REPORT OF PROCEEDINGS

OF THE

NINETEENTH ANNUAL CONVENTION

OF THE

AMERICAN RAILWAY

Master Mechanics' Association

IN CONVENTION AT

TREMONT TEMPLE,

BOSTON, MASS.,

June 15th, 16th and 18th, 1886.

CINCINNATI:
ALDINE PRINTING WORKS.
1886.

AMERICAN RAILWAY

MASTER MECHANICS' ASSOCIATION.

OFFICERS FOR 1886-87:

PRESIDENT,

WILLIAM WOODCOCK, of Elizabethport, N. J.

FIRST VICE-PRESIDENT,

J. JOHANN, of Springfield, Ill.

SECOND VICE-PRESIDENT,

R. H. BRIGGS, of Paducah, Ky.

TREASURER,

GEORGE RICHARDS, of Boston, Mass.

SECRETARY,

J. H. SETCHEL, of Dunkirk, N. Y.

REPORT.

The Nineteenth Annual Convention of the American Railway Master Mechanics' Association was held at Meionaon Hall, in the Tremont Temple, Boston, Mass., June 15, 16, and 18, 1886, President J. Davis Barnett presiding.

THE PRESIDENT—Will the Convention please come to order. The Rev. Mr. Perin will, as is our custom, invoke the divine blessing upon our meeting.

PRAYER BY REV. GEO. L. PERIN.

Infinite Spirit and loving Father, who holdest in Thy hand the laws of our world! Nature is Thine, with all her wondrous forces and varied beauty. Thou workest in nature; "the heavens declare Thy glory, and the firmament shows Thy handiwork;" out of chaos and darkness Thou has brought order and light; everywhere we see the signs of Infinite Power; over all the majestic figure of nature Thou hast thrown the flowing robes of beauty, and out of all the mystery and complexity of our world, we seem to read the story of Thy love. As we come together this morning, a company of earnest students of Thy laws, we would stand reverently before Thee, humbly confessing our ignorance. We are but children, learning to spell out the first easy words of Thy wisdom; we are only entering the primary rooms where the simple lessons of nature are being taught. Yet we thank Thee that with the spelling of these easy words, and the learning of these simple lessons, man's powers have been enlarged and his liberties vastly increased. We are glad to live in a time when man is beginning to harness the forces of nature, and use them in the industries of life. Whatever can bring the nations of the earth nearer together and show their mutual dependencies, must be a preacher of progress and righteousness, and so we would be grateful for the steamship and railroad and telegraph, which have done so much to annihi-

late time and space, and make widely separated men to be neighbors and friends.

May we not believe, O Father, that each new law and invention is another prophet of the human brotherhood, declaring with the one of old, "God hath made of one all nations of men." We thank Thee for this company of sturdy men, who are teaching the world how to economize time and strength; who delight to be explorers of Thy laws, and who with beneficent spirit gladly give the results of their discoveries to make the world wiser and stronger. May they feel that as they are working with Thee, so Thou art always working with them. As leaders of great enterprises may their work seem most honorable in their own eyes, and may they ever keep in the very front ranks of men, helping to push forward the chariot of progress. As they sit here in Council, may Thy blessing be upon them, and through the work of their hands, and their thought, may Thy kingdom come and Thy will be done. Amen!

THE PRESIDENT—In the midst of many engagements, Mayor O'Brien, of Boston, has kindly consented to come here and welcome us to this city. I beg to introduce to you his Honor, Mayor O'Brien.

Mayor O'Brien was received with applause, and responded as follows:

MR. PRESIDENT, LADIES AND GENTLEMEN: It certainly gives me pleasure to extend a cordial welcome to the members of the American Railway Master Mechanics' Association. I understand you come from nearly all sections of the country, from Canada to California, and way down in Texas. I am a little selfish in this matter, because I know that you bring with you a great deal of intelligence, and that our city will profit by your essays on subjects that must be interesting to us and to the whole country.

It is also pleasant for me to welcome you to Boston because you bring your ladies with you. I think that is a guarantee of your good behavior while among us. I think they will appreciate Boston even more than the gentlemen, because we can show them a great many things in art and style and culture which the gentlemen don't care much about.

I recognize your Association as having done more, perhaps, to develop the country than any other Association in our land. The

millionaire may spend his millions in building railroads and look for large profits, but without your brains and your intelligence to carry on all the details of his work I am afraid his profits would not amount to anything.

So far as our city is concerned, I don't know that we can show you anything very original or new in the way of improvements. We have got what we consider a very finely constructed water-works, but other cities have precisely the same, and I don't know that we excel other cities in that respect. Our sewerage system, I believe, is more perfect than that of any other city in the country. Boston proper, some time ago, had about seventy sewer outlets pouring all its filth around the city. Now we carry that out to the ocean at an expense of over six millions of dollars, and we already feel the benefit of it. Our health department shows that the life of our citizens has been prolonged by it three or four years; that is, the death rate is less to-day by three or four on the thousand than it was years ago before that great improvement was made.

I see that one of the papers to be read before your Association is "Shop Tools and Machinery." That is a subject that I think you can enlighten us upon. Boston is the only city in the country, I might say, that does not encourage mechanics. On every engine, on every little tool that a mechanic uses, Boston places a tax. I don't believe in it, and a great many of us don't, and I hope you will show us the advantage of such things so that we will make a change in that respect and encourage you mechanics to come here without taxing your intelligence, your boilers or your tools, but encourage you to go to work among us to build up the industries of the city.

Our park system, which will be a great improvement in the course of years, is rather undeveloped at the present time. We have spent millions of dollars on it so far, and expect to spend millions of dollars more, and in the future I believe our park system will make Boston the most attractive city in the Union. To give you an idea. For instance, the Charles River Park, that has been started on the borders of Charles River (a beautiful stream of water when the sewerage is removed from it) will extend six miles up the Charles River, with a stone wall embankment on its

side, will cross over to Cambridge and extend six miles down, and will be one of the finest improvements that any city in the world can boast of when completed. The work has been already commenced, and if you come here fifty years hence, perhaps you may see it finished. (Laughter.)

I should advise you to visit our Public Library, our City Hospital, and other institutions. We pride ourselves upon the Public Library. We believe it is the best in the world, and that is one of the reasons why so many eastern men go off west and locate. They are already instructed in our school of technology. They have all the advantages of our great public library, and they go off out west, and leave us here to struggle along and support all these institutions while they help you build up the great West.

I say you are more identified with the progress of the country than any other Association, and our progress during twenty years has been remarkable. It looks as though we were standing still to-day, but we are not. If you look back twenty years, what an immense—I might say, what a wonderful advance we have made in railroad building all over our country. But I can't tell you, gentlemen, anything about that, and wishing you a pleasant visit to our city I will thank you for your kind attention. [Applause.]

THE PRESIDENT—The Secretary will now call the roll.

MEMBERS PRESENT AT ROLL CALL.

NAME.	ROAD.	ADDRESS.
ANDERSON, H	204 Dearborn St.	Chicago, Ill.
BUSHNELL, R. W	Burlington, Cedar Rapids & Northern	Cedar Rapids, Ia.
BARNETT, J. DAVIS	Midland	Port Hope, Ont.
BLACK, JOHN	Cincinnati, Hamilton & Dayton	Lima, O.
BRIGGS, R. H	Chesapeake & Ohio Southwestern	Paducah, Ky.
BRADLEY, S. D	Grand Rapids & Indianapolis	Grand Rapids, Ind.
BROWNELL, F. G	Burlington & Lamoille	Burlington, Vt.
BLACKWELL, CHARLES	Union Pacific	Omaha, Neb.
BEAN, JOHN	Connotton Valley	Canton, Ohio.
CAMPBELL, E. A	East & West Texas	Houston, Texas.
CAMPBELL, JOHN	Lehigh Valley	Delano, Pa.
COLBY, G. H	Boston & Albany	Boston, Mass.
CHAPMAN, N. E	Midvale Steel Co . . . . 333 Walnut St.	Philadelphia, Pa.
COOLIDGE, GEO. A		Charleston, Mass.
COOPER, H. L	Lake Erie & Western	Lafayette, Ind.
CROCKETT, JOHN F	B., L. & N	Boston, Mass.
COOK, JOHN S	Georgia	Augusta, Ga.
COOK, ALLEN	Chicago and Eastern Illinois	Danville, Ill.
COLLIER, M. LAMAR	W. & A	Atlanta, Ga.
EASTMAN, A. G	Southeastern of Canada	Sutton, Ont.
ENNIS, W. C	New York, Susquehanna & Western	Wortendyke, N. J.
ELLIOTT, HENRY		East St. Louis, Ill.
FULLER, WILLIAM	New York, Pennsylvania & Ohio	Cleveland, O.
FINLAY, L	Hot Springs	Malvern, Ark.
FOSTER, W. A	W. & M. Div. Fitchburg	Fitchburg, Mass.
FOWLE, I. W	V. & M. & N. O. & N. E	Meridian, Miss.
FERGUSON, G. A	B., C. & M	Lake Village, N. H.
FENWICK, A	Green Bay, Winona, St. Paul	Fort Howard, Wis.
GATES, G. W	Western of North Carolina	Salisbury, N. C.
GRIGGS, ALBERT	Providence & Worcester	Providence, R. I.
GORDON, H. D	Philadelphia, Wilmington & Baltimore	Wilmington, Del.
GORDON, JAMES T	Concord	Concord, N. H.
GILMORE, W. L.	Lake Shore & Michigan Southern	Cleveland, O.
HINMAN, M. L	Brooks Locomotive Works	Dunkirk, N. Y.
HEADDEN, JOHN	Rogers Locomotive Works	Paterson, N. J.
HARDING, B. R.	Raleigh & Gaston	Raleigh, N. C.
HAGGETT, J. C	Dunkirk, Allegany Valley & Pittsburg	Dunkirk, N. Y.
HACKNEY, GEORGE	Atchison, Topeka & Santa Fe	Topeka, Kan.
HACKNEY, C	Union Pacific	Omaha, Neb.
HOWISON, N. W	C. & R	Mt. Savage, Md.
HENNY, JOHN J	N. Y., N. H. & H	New Haven, Conn.
HENNY, J. B	New York & New England	Boston, Mass.
JOHANN, JACOB	Chicago & Atlantic	Huntingdon, Ind.
KIELMER, JOHN T	812 East York St.	Philadelphia, Pa.
LYTHGOE, JOSEPH	Rhode Island Locomotive Works	Providence, R. I.
LAUDER, J. N	Old Colony	Boston, Mass.
LEECH, H. L	No. 1 Rollins St.	Boston, Mass.

NAME.	ROAD.	ADDRESS.
LANNON, WILLIAM	House of Representatives	Washington, D. C.
MAST, F. M	New York & New England	Hartford, Conn.
MEEHAN, JAMES	Cincinnati, N. Orleans & Texas Pacific	Ludlow, Ky.
MORSE, G. F.	Portland Locomotive Works	Portland, Me.
McGLENN, JAMES	Carolina Central	Laurinburg, N. C.
McCRUM, J. S	Missouri River, Fort Scott & Gulf	Kansas City, Mo.
MINSHALL, E	New York, Ontario & Western	Middleton, N. Y.
MONTGOMERY, WILLIAM	New Jersey Southern	Manchester, N. J.
MILLEN, THOMAS	New York City & Northern	New York City.
MILLS, C. W	Rochester & Pittsburgh	Rochester, N. Y.
NOBLE, L. C	Houston & Texas Central	Houston, Texas.
PAXSON, L. B	Philadelphia & Reading	Reading, Pa.
PETRIE, IRA	Jacksonville & Southeastern	Jacksonville, Ill.
PERRY, F. A.	Cheshire	Keene, N. H.
PRESCOTT, G. H	Terre Haute & Indianapolis	Terre Haute, Ind.
PORTER, J. S	Indiana, Bloomington & Western	Sandusky, O.
PLAYER, JOHN	Central of Iowa	Marshalltown, Ia.
PILLSBURY, AMOS	Eastern	Boston, Mass.
PITKIN, A. J.	Schenectady Locomotive Works	Schenectady, N. Y.
RANSON, THOMAS W.	Indianapolis & St. Louis,	Mattoon, Ill.
RICHARDS, GEORGE.	Boston & Providence	Boston, Mass.
REYNOLDS, G. W		Taunton, Mass.
ROBERTS, E. M	Ashland Coal & Iron Co.	Ashland, Ky.
ROBERTSON, W. J	Central Vermont	St. Albans, Vt.
STONE, W. A	New York & New England	Norwich, Conn.
SCHLACKS, HENRY	Illinois Central	Chicago, Ill.
SMITH, W. T	Chesapeake & Ohio	Huntington, W. Va
STRODE, JAMES	Northern Central	Elmira, N. Y.
STEARNS, W. H	Connecticut River	Springfield, Mass.
SHAVER, D. O	Pennsylvania	Pittsburgh, Pa.
SETCHEL, J. H	Brooks Locomotive Works	Dunkirk, N. Y.
SPRAGUE, H. N	E. K. Porter & Co	Pittsburgh, Pa.
SMITH, WILLIAM	Boston & Maine	Boston, Mass.
STEVENS, G. W	Lake Shore & Michigan Southern	Cleveland, O.
SELBY, W. H		Moberly, Mo.
STEWART, O	Fitchburg	Charlestown, Mass,
STINARD, F. A	New York & Greenwood Locks	Pompton Junction, N. Y.
SHORT, WM. A	Ogdensburg & Lake Champlain	Malone, N. Y.
SMITH, WM. F.		Carlin, Nev.
TANDY, H.	Canada Locomotive Works	Kingston, Ont.
TWOMBLEY, T. B.	Chicago, Rock Island & Pacific	Chicago, Ill.
TURREFF, W. F.	Cleveland, Columbus, Cin'ti & Ind.	Cleveland, Ohio.
TAYLOR, J. K.	Boston & Lowell	Boston, Mass.
THOMPSON, JOHN.		Boston, Mass.
TORRENCE, JOHN	Evansville & Terre Haute	Evansville, Ind.
WAKEFIELD, S. W.	Chicago, Rock Island & Pacific	Keokuk, Ia.
WIGGINS, J. E.	S. P. & T. N.	Marshall, Tex.
WOODCOCK, W.	Central R. R. of New Jersey	Elizabethport, N. J.
WILLIAMS, E. H.	Baldwin Locomotive Works	Philadelphia, Pa.
WIGHTMAN, D. A.	Pittsburgh Locomotive Works	Pittsburgh. Pa.

NAME.	ROAD.	ADDRESS.
WHITNEY, H. A.	Intercolonial	Moncton, N. B.
DEAN, F. W.		East Taunton, Mass.
FORNEY, M. N.	29 Murray Street,	New York City.
MILES, F. B.		Philadelphia, Pa.
SINCLAIR, ANGUS.	187 Dearborn Street,	Chicago, Ill.
SEDGELY, JAMES		Cleveland, O.
PHILBRICK, J. W.		Waterville, Me.
EDDY, WILSON		Springfield, Mass.

The Secretary announced that seventy-seven members were present or known to be in the city.

The President then delivered his annual address.

LADIES AND GENTLEMEN: It is a real pleasure to meet with you, and greet you once again.

Your happy faces tell a tale of good health, of high spirits, and of ability to respond to and enjoy, not only the civic hospitality so kindly extended to us by this good city, but to appreciate all its other good things. I have often expressed my personal feeling, that Boston is the most charming city to visit on this continent. I regret that I was not a member, and, therefore, had not the pleasure of the convention held here fourteen years ago (1872), yet those who were—I know by their vivid recollections of that time—have most happy remembrances of the right hearty way in which our Association was welcomed, and its financial position then strengthened; and we believe that the warm words of welcome we have just heard from his Honor, Mayor O'Brien, are a genuine expression of Boston's feeling toward us.

I am glad to say our Treasurer's and Secretary's reports are encouraging; they show an unspent balance of $453 71, and that our membership has not lessened, although, to our sorrow and regret, since last we met five members have gone over to the majority. May they rest in peace.

It is possible that the change of rail-gauge from broad to standard, carried out during the last few days in the Southern States, may yet keep the members there resident so busy that we shall not see all of them this year. Should this unfortunately prove to be the case, I much regret that the dates should have fallen so close together as to make it impossible for all to attend this meeting;

which I had hoped, and still shall hope, will not fall behind any previous one, either in attendance, interest, or educational value.

That the ladies continue to favor us with their presence and kind smiles, is a matter of happy congratulation; and they must not think my thanks are not real, and the words are feigned, even if they do come from a bachelor.

This morning, more particularly to our working and junior members, I wish to speak a few words on the "Uncertain in Locomotive Engineering" and how we can best reduce it.

The certain is the concrete results of past experience, it is familiar, prosaic, and it fails to keenly interest or stir us; but that which is still uncertain, still undefined, the test or experiment our friend has in hand, the problem we are trying to solve, these unconsciously draw out our enthusiasm; as we thus hope to attain one more point of indisputable fact, to make the foundation of our daily practice more firm, to take another and a closer grip on nature; and it is this continually attaining, this breaking down of the barriers, this wider survey and clearer plotting of what recently was an unknown territory, that gives the growing interest to our profession, and to these our annual reunions.

Critics (and not necessarily unfriendly critics) have said, that individually in convention we make contradictory statements, and collectively our published proceedings are conspicuous by the absence of definite conclusions and formulated results.

It seems to me, that there is small cause for wonder that statements appear to be contradictory, when it is considered how numerous are the differences in metal, in fuel (and, can I add, in men); how great the variation in service the materials are put to; and also over how many substances one word is stretched to cover. May I illustrate: we commonly use the word "soft coal" as if it were a single, definite, almost elementary substance, ignoring the fact that the varieties from the same bed and seam are numerous, and that two specimens which chemical analysis shows to have practically equal percentages of the same constituents, are seen to behave very differently when distilling on the grate, yielding different residues, as well as showing large variation in calorific power.

"Steel" is another common instance in illustration: what a be-

wildering variety of substances, with highly differentiated qualities does this little word cover; and how wide the differences necessary in its treatment, from tool steel injured by high heat, to boiler plate, which is made dangerous to human life if it has been worked at low or colorless heats.

Therefore, when circumstances so greatly differ, and the use of a similar word is so far from implying that a similar substance is referred to, should it be a matter of surprise, if a member's statement that so and so is *black*, is directly followed by another's that it is *white?*

The thought I desire to impress upon you, is the necessity for noting and fully stating all the qualifications or circumstances limiting the observed fact; we shall then see these apparently diverse statements fall into parallel line, and the conclusion (in many, if not most, cases endorsed by the majority) show that it is *grey*, or a mixture both of black and white.

All the circumstances qualifying, influencing, or seemingly only coincident with an observed experiment, should be noted. For the trend of modern scientific research is to show that it is the small circumstance (so small and apparently so trivial as to be overlooked for years) that proves to be the missing link, the missing ward in the key that unlocks the puzzle, showing the complete yet simple operation of cause and effect.

We need to educate the closely observant eye, that will *not* be deceived by superficial appearance into lazily concluding that the apparently familiar result is exactly the old well-known incident, with nothing but the old lesson to teach, and the old law to enforce.

Hence the value of seeing any fact in physics—with our own eyes; and also, because of the liability to visual deception, of seeing the same thing through the eyes and mind of one or more independent observers, of noting the points brought out, that to them seem most prominent and closely related, the sequence or order in which they follow, and their relative proportion to, and influence the one on the other.

We can, I think, best get into this good habit—considering the pressing limitations due to time and business calls—by free mutual exchange of experiences, and our association is based on that belief,

but each statement we make, to be current at its full value, must be specific, something more than a flat contradiction, or an "I don't think so." Let us strive to give the *why*, as well as to state the naked fact, that in our observation it *is* so.

We can by striving, get the *why*; for it is certain that regularity and eternal law reign throughout the most diverse results. This is our unshaken foundation. If results seem to vary, it is because we either do not know, or have not observed the conditions that insure success. The defect is in ourselves, for nature's laws know "neither variableness nor shadow of turning." Open eyes, unblinking observation, energy, and freedom from foregone conclusion are necessary; not that nature is deceitful, but she does not disclose her hidden charms, except to those who ardently seek them!

Foregone conclusions are a fruitful source of error. Let us for an illustration turn again to steel, used successfully to sustain rolling friction, yet a failure when inferential reasoning led to its application to resist rubbing or sliding friction. To make a fair trial of the rolling of steel tires on steel rails, was to recommend the exclusive use of steel, it did its work so well, had so long a life, such little frictional resistance, and possessed such high powers for resisting abrasion; yet the attempt to *slide* one polished steel face upon another—as an eccentric inside its strap, or a cross-head upon its slide-bar—has not to-day reached the stage of successful experiment.

It is now clear, that any inference obtained from experiment in rolling friction between metals, will not apply to sliding friction; to think you can do so is a futile attempt to get at nature's law by a foregone conclusion. The same may be said of any attempt to apply resistance rules deduced from friction at low velocities, to practice at high velocities, and it was unwise to expect that boiler-plate with $\frac{1}{300}$ part of carbon, would behave the same as if it contained but the $\frac{1}{700}$ part, or even a more minute fractional part of phosphorus.

These are trite examples, but they the better serve to emphasize the necessity for clear discrimination between things that seem to differ (if at all) but very slightly, and also to remind us to properly qualify and elucidate our statements, and to closely observe the small things.

Dr. G. Gore has shown how widespread and inclusive are the influences of seemingly small causes. Thus warmth, or even moderate pressure, applied to a piece of steel, definitely, and in most cases measurably, altered its "length, breadth, thickness, molecular arrangement, atomic distance, specific gravity, cohesive power, adhesion to liquids, elasticity, temperature, specific heat, latent heat, thermic conductivity, thermo-electric power, electric-conduction resistance, magnetic capacity, chemical and chemico-electric actions, and a number of other properties simultaneously," so that his vivid experiments almost produce the impression that this metal is endowed with vitality. Thus, although we need not pay attention to all these points, you see that if we treat metal as inert and stable under all except extreme variations of temperature and pressure, we shall be deceived, and find our attempted application of experimental results to daily practice very disappointing; but if we carefully discriminate and notice the small signs we shall make fewer mistakes, have less failures in daily work, do something to lessen the still wide field of the uncertain, and increase the present narrow swath of the known and certain.

May I now thank you for the kind and considerate attention with which you have listened to this dry prosing. Remember, in extenuation, that it is the 19th year you have listened to an address from the chair and the possibilities of something new and interesting to all seem—at least to me—very limited.

The President—The Secretary will now present his annual report.

The Secretary's report was read and, on motion, received.

SECRETARY'S REPORT.

Boston, June 15, 1886.

To the American Railway Master Mechanics' Association.

Gentlemen: I have again the pleasure of submitting for your information a detailed statement of the transactions of my office for the year ending with this our Nineteenth Annual Convention.

MEMBERSHIP.

Since last report of the Secretary, twenty-two full members and two associate members have united with the Association. Three names have been dropped from the rolls for non-payment of dues,

and it is with due solemnity and regret, that duty compels me to announce that five well-known names will be sadly missed at our future gatherings. George Boyden, M. M. Pendleton, S. H. Dotterer, J. C. McCune and John Ivanson are *dead*. With these changes the Association numbers ten honorary members, fourteen associate and two hundred and forty-five full members, making a total of two hundred and sixty-four, as against for last year two hundred and thirty-six.

PRINTING.

The printing of our Annual Report was again awarded to the Aldine Printing Works, of Cincinnati, they being the lowest and best bidders, for the sum of four hundred and fifty dollars, for twelve hundred copies of one hundred and eighty-eight pages each.

The engraving was done by the *Railroad Gazette*, at a cost of three hundred and twenty-seven dollars.

REPORTS DISTRIBUTED.

Seven hundred and eleven of these reports were sent out to the various railroads and other parties, in most cases accompanied by a modest request for a contribution to our printing fund. Two hundred and sixty-four have been sent to members, and two hundred and twenty-five are now on hand. A full set of reports was asked for from the Patent Office Library of London, Eng., which were supplied with the compliments of the Association.

PRINTING FUND.

Nearly all of the old subscribers to the printing fund have renewed their subscription this year. The following is a list of the names and the amounts contributed to this fund:

South-Eastern R. R.	$10.00
New York, Lake Erie & Western R. R.	10.00
W. W. Evans	5.00
Intercolonial R. R.	20.00
Rochester & Pittsburgh R. R.	10.00
Nathans Manufacturing Company	25.00
Connecticut River R. R.	10.00
Rogers Locomotive Works	50.00
Illinois Central R. R.	10.00

Missouri Pacific R. R.	10.00
Cleveland, Columbus, Cincinnati & Indianapolis R. R.	10.00
Midvale Steel Works	25.00
Pittsburgh Locomotive Works	10.00
Lake Shore & Michigan Southern R. R.	10.00
Boston & Providence R. R.	10.00
Central of Iowa R. R.	10.00
Portland Locomotive Works	10.00
Kelly Lamp Works	10.00
Providence & Worcester R. R.	10.00
Baldwin Locomotive Works	20.00
Detroit, Lansing & Michigan R. R.	10.00
Lehigh Valley R. R.	10.00
Chicago & Eastern Illinois R. R.	10.00
Chicago, Rock Island & Pacific R. R.	10.00
H. K. Porter & Co.	10.00
Delaware, Lackawanna & Western R. R.	10.00
Rhode Island Locomotive Works	10.00
Niles Tool Works	20.00
Fitchburg R. R.	10.00
Des Moines & Ft. Dodge R. R.	10.00
Atchison, Topeka & Santa Fe R. R.	10.00
Louisville & Nashville R. R.	10.00
Cincinnati, New Orleans & Texas Pacific R. R.	10.00
Boston & Albany R. R.	10.00
Chesapeake & Ohio R. R.	10.00
Terre Haute & Indianapolis R. R.	10.00
Cleveland, Akron & Columbus R. R.	10.00
Grand Trunk R. R.	10.00
Chicago, St. Paul, Minneapolis & Omaha R. R.	10.00
Chicago & Alton R. R.	10.00
Chesapeake & Ohio South-Western R. R.	10.00
Grand Rapids & Indiana R. R.	10.00
Brooks Locomotive Works	25.00
Houston & Texas Central R. R.	10.00
Wisconsin, Iowa & Nebraska R. R.	5.00
William E. Lockwood	10.00
Mobile & Ohio R. R.	10.00
Old Colony R. R.	10.00
Reading R. R.	10.00
Total,	$595.00

The following is a correct statement of all monies received during the year:

Assessments	$1,256.00
Initiation	22.00
Printing Fund	595.00
Sale of Reports	64.50
Total,	$1,937.50
Balance from last year	$308.26
To be accounted for	$2,245.76

For all of which I hold the Treasurer's Receipts.

The Boston Fund, the nucleus of which was presented to the Association, by its friends in this city, consisting now of a principal of $5,294, invested in Government Bonds, and an uninvested interest from last year of $98.93, the July interest of 1885 of $52.00, October interest of $52.00, or January interest of $52.00, and an April interest of 1886, of $52.00, making a total of uninvested interest of $306.93, is still retained in the vaults of the Safe Deposit Company of Cincinnati, for which is paid an annual rental of ten dollars per year. This interest will doubtless be ordered invested, as provided by our By-Laws at the first meeting of the Trustees.

The following letter will be interesting and will explain itself:

NEW YORK, June 10, 1886.

J. H. Setchel, Esq., Secretary Master Mechanics' Association, Dunkirk, N. Y.

MY DEAR MR. SETCHEL:—Enclosed please find check for one hundred and sixty-one dollars and thirty cents, which is the *balance* from a fund, subscribed by the business men who deal with railroads, for the entertainment of the Master Mechanics at Washington meeting. I was instructed by the Entertainment Committee to send the balance of fund to your Association, and respectfully request the acceptance of the same with the compliments of the subscribers. I intended to give you the check in Boston, but sickness in my family may prevent my attending the meeting.

I remain, yours very truly,

C. A. MOORE.

All books, papers, and accounts, pertaining to the foregoing are respectfully submitted.

Very respectfully,

J. H. SETCHEL.

The President—The Treasurer's report is next in order.

The Treasurer's report was then read, and, on motion, received.

TREASURER'S REPORT A. R. M. M. A.

Cash on hand	$ 10.96	
June 14th, received from J. H. Setchel, Sec'y	2,235.76	
		$2,246.72
Received from J. H. Setchel, Sec'y		10.00
Expenditures—		2,256.72
Dunkirk Printing Co.	$ 11.00	
" " "	16.75	
" " "	4.50	
Secretary's Salary	800.00	
Aldine Printing Works	450.00	
Brooks' Locomotive Works, for Blue Prints	12.43	
J. H. Setchel, Postage	66.95	
C. F. White, Stationary	3.75	
Safe Deposit	10.00	
C. A. Morrison, Reporter	100.00	
R. R. Gazette, Engraving	327.63	
		$1,803.01
Cash on hand,		$453.71

GEO. RICHARDS, Treas.

Boston, June 15, 1886.

The President—We will now take a recess of ten minutes to enable members to sign the roll.

NEW MEMBERS.

NAME.	ROAD.	ADDRESS.
AMES, L. M.	B. C.	Jersey Shore, Pa.
BALL, CHAS. A.	Brooklyn Elevated	Brooklyn, L. I.
BARNETT, T. E.	Canada Pacific	Vancouver, B. C.
CLARK, ISAAC W.	C. F. & Y. V.	Fayetteville, N. C.
ETTENGER, G. W.	Chesapeake & Ohio	Richmond, Va.
FLAHAVHAN	P. & W	Allegheny City, Pa.
HOBART, C. C.	Oregon Railway and Navigation Co.	The Dalles, Oregon.
HAINES, S. W.	Pittsburgh & Lake Erie	Pittsburgh, Pa.
HAGGERTY, GEO. A. V.	The E. W. Brunswick Railways	St. John, N. B.

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NAME.	ROAD.	ADDRESS.
HAINES, GEO L	Richmond & Allegany	Richmond, Va.
GENTRY, F. W.	Richmond & Danville	Atlanta, Ga.
KOLSETH, HENRY S.	Boston & Lowell	East Cambridge, Mass.
MORROW, WM. H.	Baldwin Locomotive Works	Philadelphia, Pa.
SMART, C. E.	Michigan Central	Jackson, Mich.
SHAW, THOMAS	Franklin Institute	Philadelphia, Pa.
TWOMBLY, A. W.	Old Colony	Taunton, Mass.
WALKER, C. W.	Seaboard & Roanoke	Portsmouth, Va.
WEISGERBER, E. L.	Baltimore & Ohio	Newark, O.
WILLARD, DANIEL	M., S., St. M. & A.	Turtle Lake, Wis.
WANKLYN, F. L.	Grand Trunk	Montreal, Can.
AUSTIN, WM. L.	Baldwin Locomotive Works	Philadelphia, Pa.
DAVIS, JAMES A.	Napanee, Tamworth & Quebec	Deseronto, Ont.

RECESS.

After recess the President called the Association to order, and announced that the first business in order was the Report on Boiler Construction.

W. E. LOCKWOOD—Mr. President, before that is taken up I wish to ask the attention of the Convention to a resolution which I think will be adopted without discussion.

THE PRESIDENT—I think you are out of order at this time.

MR. LOCKWOOD—I understand that the reading of last year's minutes would be in order. They have not been read, and I wish to make a correction in them in three or four particulars. As the last year's report now stands it is incorrect. I do not intend any reflection on the Secretary in asking that these corrections be made. If I am out of order I ask unanimous consent of the Convention to suspend the regular order of business for the purpose of offering the resolution and one or .wo motions.

THE PRESIDENT—I believe the minutes have been considered as read with the Secretary's report, inasmuch as they are all in the hands of the members of the Association before they come to the Convention, but if the minutes are not correct we would like to have them corrected, of course.

MR. LOCKWOOD—That is what I supposed, and it is for our future good that they should be strictly correct and that every gentleman may stand precisely upon what he says. I know that these reports are becoming more and more valuable every year. I hope the Secretary will understand that I mean no reflection upon him in this matter. I understand what a shorthand reporter's minutes are, and how difficult it is for him to get them correct. I have asked unanimous consent to offer this resolution.

D. O. SHAVER—I second Mr. Lockwood's motion.

SECRETARY SETCHEL—Mr. President, I know that in bodies where minutes are kept and expected to be approved, the motion of Mr. Locwkood would be eminently proper, but it seems to me that in a body where the reports are taken down by a shorthand writer, as they have always been by us, and printed without the privilege of revision by members, it being taken for granted that they are correctly reported in the main, it does seem to me that Mr. Lockwood's motion is entirely out of order. There probably is not a gentleman within the sound of my voice who may not, in looking over the report of our proceedings, say: "That was not just what I said:" or, rather, he may soften it somewhat and say: "This is not what I intended to say," and yet probably what the reporter understood was said, and also probably what some member who followed immediately after understood him to say and answered accordingly. Now then, that b ing the general understanding, it must go into the minutes in that way, in order not to make the man who follows in the discussion appear at a disadvantage. There would be no end of corrections if we were to adopt the course suggested by the gentleman, and our reports would all have to be reprinted. But going forth with the understanding that these are off-hand discussions taken down by the shorthand man, and notwithstanding errors may occur, they are understood and taken as errors, and it is impossible for us to go back and correct what every man has said. It has never been done and certainly will be an innovation in this Association that I hope will not be commenced now. I certainly hope that the motion will not prevail, and I move as an amendment that the minutes be accepted without reading.

MR. LOCKWOOD—I wish to state now briefly four cases in which error exists, and in which the statement does not make sense. I will ask the Secretary to look at page 51. Last year I was not a member of the Association, and yet on that page I am represented as offering a paper recommending the election of Mr. Grimshaw to membership.* I filed no such paper. It was nother paper entirely which I did file. I wish to have the minutes corrected in that respect. Then there is a still more important matter. We had discussed the question of the government of the United States having a museum, and Mr. Lauder offered a resolution which was unanimously adopted. I wanted to find that resolution only last week, and I had to go to a railway paper to find it. [See note in another place.] It is not in the report of our proceedings at all.

*NOTE.—The error lies in recording what an individual *not* a member said at a time when the Secretary was speaking of receiving an application for associate membership from Robt. Grimshaw.

Again, I am quoted as saying that the speed of rotation was combined with the speed of location. I said it was the speed of *translation*, not location. Within the past three months I have employed a most skillful shorthand reporter, a man who teaches over three hundred scholars, and he told me he would never undertake again to report a mechanical discussion. We get by sound an idea, and the same sounds may convey different meanings. I next have a resolution to offer to carry out a resolution which we passed last year which is omitted in this report, and I will submit it without discussion. I want the government of the United States to enter into this thing.

SECRETARY SETCHEL—I haven't time to look into the facts in the case, but I adhere to what I stated previously, that while it may be in order to call attention to these errors we cannot correct them, simply because we cannot recall our minutes and put in Mr. Lockwood's name or strike it out and put in the name of some other man who, perhaps, the Secretary understood the name to be. That is an utter impossibility, and I think there can be a great deal more harm done by these corrections than there will be by the minutes going out as they are. While I am glad to have anything in the minutes that is wrong corrected, the only way that we can do it is to have notations taken of such errors, and exercise more care in the future.

W. E. LOCKWOOD—That is really all I wanted.

JACOB JOHANN—I certainly cannot agree with Mr. Lockwood to have any corrections made in the minutes. These annual meetings are for the purpose of interchanging views and placing upon record the various improvements that have been made in the course of time, and, as a matter of course, a member may sometimes not be distinctly understood, and his remarks go into the report in a way that he may afterwards, when he reads it over, find fault with, and he would like to have it read some other way. I know I have been reported that way myself, but I haven't found any fault with it. To commence to correct the minutes, I think, will throw in a discord here that will have no end. In my opinion, this Society is not responsible for the individual opinion of any of its members. Whatever goes on the minutes is a member's individual opinion. If Mr. Lockwood is incorrectly reported I think there will be no objection to putting in some paragraph in the next report correcting it. I think Mr. Lockwood is fairly reported, only he seems to think now that he ought to be read up a little different from the way he is.

R. H. BRIGGS—I think Mr. Lockwood has just cause for complaint. It is a very small affair for the Secretary to issue a circular correcting page so and so, where Mr. Lockwood is reported as having made a

ridiculous statement. We are all liable to make mistakes, and if I thought that a remark that I should make here would be ridiculously reported and not corrected, I should be very loth to get up again. I am in favor of making the correction, and I move that the correction be made by circular.

H. N. SPRAGUE—I think that in so far as Mr. Lockwood is reported in last year's report as recommending the election of two members, the report should be corrected in that respect. But as to correcting a word used in debate on mechanical matters I am very much opposed to it. I think I have been misquoted once or twice here, but to allow a member in cooler moments to correct something he says in the heat of debate will, in my opinion, lead to an almost endless job.

F. B. MILES—I would propose to the Association that something of this sort be done: that at each meeting of the Association any member having complaints to make should do so to the Supervisory Committee, and then in the back part of the next report of our proceedings there should be a page of errata devoted to the correction of anything which that Committee thinks proper to correct.

G. W. STEVENS—If Mr. Lockwood had been correctly reported in substance even, in my opinion, he wouldn't have cared. To call up now each and every error made, in the exact language used in that report, will be, as Mr. Johann says, an almost endless job. Still it is a lamentable fact that there are errors in the reports of this Association. I know that the *Railway Gazette* pointed out several ridiculous errors. For instance, one error was where the word "Creme" was used instead of the name "Crewe," and other similar typographical mistakes. I also saw in the report of some remarks of Mr. Forney where he was quoted as advocating four thousand (4,000) square feet of heating surface in a boiler. Now, all such ridiculous errors as that should be co rected.

W. E. LOCKWOOD—I second Mr. Miles' amendment to the amendment.

H. N. SPRAGUE—Mr. President, I didn't understand what the amendment to the amendment was.

F. B. MILES—My amendment was that at every meeting of the Association the Supervisory Committee should hear the complaints of any members who think they were not reported correctly at the previous meeting, and that then that Committee should (if in their judgment the complaints are proper), have a page in the next report devoted to correcting such mistakes in the previous report. That would cure the evil once for all, without useless discussion.

H. N. SPRAGUE—It strikes me that that puts the thing in the shape it

was before; that it gives every man a chance to correct his statements. What have you got then to go back to?

F. B. MILES—To the Supervisory Committee. They would have the power to settle whether the report should be corrected or not.

H. N. SPRAGUE—Yes; but if the Supervisory Committee accepts a correction of one member, they would have to accept it from all members. If one man makes a statement and the Committee accepts it, they cannot in the future refuse to accept any other man's statement who says he is not correctly reported.

F. B. MILES—Then, gentlemen, we have got to submit to the dictation of a short-hand pope, and I don't think we are prepared to do so.

G. W. STEVENS—I think Mr. Sprague does not understand the question exactly. If a man is reported in substance correctly it does not matter about the form. That is the way I understand it.

W. E. LOCKWOOD—Yes, sir; that is so. I would be willing even to leave it to a statement of facts. It is the facts that we want correctly reported.

SECRETARY SETCHEL—In looking over the minutes I find that Mr. Lockwood has misapprehended the facts of the case entirely. At the opening the Secretary stated that there was some other preliminary business, and that there were some communications for associate membership. Then Mr. Lockwood interrupted and said he had a communication to present. My recollection is that he was declared out of order, and his remarks should not have been reported.

W. E. LOCKWOOD—That is correct.

SECRETARY SETCHEL—And then the Secretary goes on to read a paper; not the paper presented by Mr. Lockwood at all.

MR. LOCKWOOD—No, sir; that is later on.

SECRETARY SETCHEL—No, sir. The Secretary read the paper to which the Secretary had previously referred. Not Mr. Lockwood's paper at all.

MR. LOCKWOOD—But on page 51, after I had made my statement, it says: "The Secretary read the paper," &c. Now, that clearly would lead a person to infer that the Secretary read the paper which I presented.

SECRETARY SETCHEL—No, sir; I think not. The Secretary read the paper that he had previously mentioned when interrupted by Mr. Lockwood. The Secretary stated: "As all the members are not here at this time, and I have here a communication for associate membership." Then Mr. Lockwood said: "I have a communication to present, and would place it before the Convention now, that it may be referred to the Committee on Associate Membership, and I will confer with them in relation to it." Some committee was understood, and I have it here

"Committee on Associate Membership," which is evidently correct. Then the Secretary reads the communication he had before referred to.

MR. LOCKWOOD—That identical communication which the Secretary referred to is the paper which I have read, and Mr. Lockwood was ruled out later on when he offered the resolution which is now before this meeting as the report of the Committee.

SECRETARY SETCHEL—The communication that was referred to here was a communication for associate membership not presented by Mr. Lockwood.

ANGUS SINCLAIR—The hour has arrived that is usually devoted to other business. I, therefore, move that this whole matter be laid on the table.

JACOB JOHANN—I second the motion.

(The motion to lay the subject brought up by Mr. Lockwood on the table was put to vote and prevailed.)

THE PRESIDENT—Are there any questions to be discussed during this time?

SECRETARY SETCHEL—The first question presented is one handed in last year by Mr. Stevens, and laid over for this year. "What good are self-dumping ash-pans?"

G. W. STEVENS—What prompted that question is that during the past two years the officers of my company have been called upon occasionally to adopt self-dumping ash-pans, and parties have been fortified each time with a circular letter stating that there is a great saving in the consumption of coal by using this ash-pan. The question now arises: How much of this saving is due to the ash-pan, and how much to the use of slack coal? They say there is a saving of fifteen pounds of coal on each mile run, amounting to some four hundred and fifty tons of coal for each 100,000 miles' run.

Now, if there are some gentlemen here that have pans of that character on their road, and if the saving can be shown to be as much as that, it is certainly information that ought to be brought forward, and if it can't be shown the matter of giving testimonial or recommendatory letters for publication ought to be stopped.

R. H. BRIGGS—Is this ash-pan supposed to have effected that saving?

MR. STEVENS—Yes, sir.

MR. BRIGGS—Exclusively?

MR. STEVENS—Yes, sir.

MR. BRIGGS—Then I say it is a very remarkable thing.

M. L. COLLIER—About six months ago I put one of those ash-pans on a 17 x 24 ten-wheeler, on the Western & Atlantic Railroad, based alto-

gether on the testimonial letter referred to by Mr. Stevens. The ash-pan was given a fair trial. There was no question about that. We failed to see that there was any saving in it in any way. It is a very good ash-pan, so far as the requirements of an ash-pan go, but as to saving anything we failed to discover it. In fact, I think we have engines of the same class, with the ordinary ash-pan, that burn less coal.

JACOB JOHANN—I have not yet seen why a self-dumping ash-pan should be more economical than any other in the consumption of fuel. I always looked upon it as a matter of convenience, possibly, in cleaning out the ash-pans. Then, again, it always appeared to me that, while it may have some good points in the direction of cleaning out the ash-pans, still the objections to it were so much greater that I haven't even cared to test the device. Speaking about the self-dumping ash-pans, I am reminded of my observations on my trip coming here from Chicago. I saw innumerable quanties of ties burning between the rails, and it struck me as very remarkable, for I could not think where so many fires came from. It is barely possible, I think now, that they were experimenting with self-dumping ash-pans, and that the fires were set in that way. I know the country is just as dry where I am as it was on that railroad, and we never find any such fires along the line of our road, and whether they were caused by the self-dumping ash-pans or not, I am not prepared to say. I asked a brakeman what the trouble was, whether they were dumping their ash-pans or not. He didn't know. He said the country was very dry, and the fires might have been set by sparks. Of course such fires are to be guarded against, and I think it is very possible that the engineer was experimenting, as I have stated.

M. L. COLLIER—There is one thing that is claimed for the self-dumping ash-pan especially, and that is, that if the main fire is raked from the grates properly into the ash-pan, and allowed to remain there during a run of half a mile or so, that it is then cooled, and can be dumped without any danger of setting fire. If I understand the matter, it originated on the north-western prairies just to overcome that very thing—the liability of setting fires by the dumping of ashes and hot coals. We all know that in the ordinary ash-pan if you sift the fire while running it blows the fire on both sides of the road, but with this ash-pan there is no danger of sifting hot coals on the track. I repeat that so far as the requirements of the ash-pan go, in holding the fire and dumping it at your pleasure, without having to go fifteen or twenty miles to a station until it gets cool, you can reverse the bar and let it fall down.

H. A. WHITNEY—We have several of those self-dumping ash-pans

in use on our road, and while they do not effect much saving in the consumption of coal, yet we think it effects a saving in another way, and that is, it saves handling our ashes at the round house ; they are dumped out on the road, and if the engineer exercises a little care there will be no danger from fire at all. If a fire is started it is because the engineer has been careless. One object we have in using the self-dumping ash-pan is, that with us, in the winter time, when our trains are running in snow storms, the ash-pans are apt to get filled up with snow, and it melts and forms ice, and frequently freezes the bar so that it can't be dumped, and the men have to get down underneath in the snow and pick that out; but by the use of the self-dumping ash-pan, shaking the bar frequently, but not too much at a time, the ashes are dumped into the pan, and then before the snow can get in there and freeze, the bar is raised and the ashes are tipped out. We can make runs in winter time of one hundred and eighty miles, with the dumping-pan, without once raking the fires.

The only way that any saving can be effected by the dumping-pan is that by keeping the fires clean less coal is burned. The air gets through more readily, and it don't require such a strong draft, which must be the case unless they are frequently dumped.

J. S. McCrumm—I have failed to see wherein the self-dumping ash-pan can be of any possible advantage. It occurs to me that in some sections of the country, in the West, that it will be a very unsafe thing to use. It is hardly possible that the fire that would be shaken into the ash-pan from the grates would all be extinguished before it is dumped out. This matter was presented to me two or three years ago, and I took the view that it was not consistent for us to undertake to use them. Possibly where you have stone ballast, you might dump your pans without danger, but I don't believe you could do so in our western country. In reference to the question of ice and snow getting in the pans in the winter, I can see perhaps where there might be some advantage in the use of the self-dumping ash-pans in that direction. But it occurred to me that the disadvantages were more than the advantages. That is my view of the matter.

R. H. Briggs—Mr. President: It looks to me as though we were wasting a great deal of time on an ash-pan. Here are gentlemen speaking of the advantages of an ash-pan in the winter time being self-dumping, so that he can get rid of snow and ice—why, I generally dump the ash-pan in just such a time as that, so as to melt the ice. It seems to me that the advantage would be greater to the fire without the ash pan than it is with it. I move now that we dump the ash-pan.

G. W. Stevens—I offer this Resolution:

Resolved, "That this Association deprecates the giving of testimonials or recommendatory letters for publication, and enjoins all to restrict matters of this nature to letters of inquiry."

H. B. MILES—I second the Resolution.

M. L. COLLIER—I am in favor of that Resolution, and I think that the remarks which led to the discussion of this question are eminently proper, and the reason that the subject was presented is, a thing goes out as indorsed by the Master Mechanics here and there, when the thing is really a failure. I am opposed to anything of that kind. Men should be more careful about indorsing these things.

THE PRESIDENT—The motion, it seems to me, amounts to a recommendation that we should be straightforward and honest.

G. W. STEVENS—Yes, sir; but the Resolution carries its own weight with it. It simply deprecates the giving of testimonials or recommendatory letters. It is a rule of the Pennsylvania Railroad never to give any such letters; but you can get such information if you want it by writing to them for it, but they don't believe in giving testimonial letters.

JACOB JOHANN—This Resolution is very good, but I think we can put a great deal more force to it by each member of this Association just delegating himself a committee of one and saying that he won't give any such recommendations. That is what I have been doing for the last ten or twelve years, and if every member will do that, it won't be necessary to pass this Resolution. At the same time I see no impropriety in passing it. If anything comes to me with a recommendation or testimonial attached to it, I do not pay any attention to it. I say that "the proof of the pudding is in the eating," and I want to eat it.

[The question was then put on the Resolution proposed by Mr. Stevens, and it was adopted.]

THE PRESIDENT—Have you any other communications, Mr. Secretary?

SECRETARY SETCHEL—Yes, sir. Question No. 2 is as follows: "Is the present form of Quadrant satisfactory as a means of regulating the cut off?"

ANGUS SINCLAIR—Mr. President, this subject was suggested to me by experiments I have been making lately with the Indicator. I find that an engine, say one that would haul a train, cutting off at six inches, would, if they had but a slight increase of pull, and the same amount of steam being admitted was too little at that, they would have to drop down to nine inches. That was generally about the way it ran. At that, the steam emitted was too great, and consequently it had to be

throttled. To a great extent a locomotive can be made to approximate the performance of an automatic engine, if the steam is admitted to the cylinders unthrottled; but if it has to be worked all the time, as in a case of that sort, the locomotive works under the disadvantage of a badly throttled engine. The conditions are about equal, and I find in figuring up the indicator cards under the two conditions, that there would be from fifteen to twenty per cent. more steam used to the same amount of work, when the engine was throttling, that would be used if the quadrant could be regulated to admit the steam unthrottled; that is so that instead of cutting off at nine inches they could drop down to seven and a half inches. If you can divide the cut-off you would have a very considerable advantage in the saving of steam, and I think it would be desirable for invention to go in that direction. In some places a screw has been applied as a means of regulating the cut off; that is, the engine is reversed by a screw instead of a notched quadrant, and I know that considerable advantage has been derived therefrom. Those who are familiar with the steam reverse gear are also aware that considerable advantage has been derived from it, from the fact that the admission of the cut-off could be regulated much finer than by the quadrant. If anything could be done in that direction, in even a simpler or cheaper way than the steam reverse, I think it would be desirable, and would be an improvement to American locomotives if it were adopted.

SECRETARY SETCHEL—A question has been suggested to me by a member as to the value of substituting a rectangular exhaust tip instead of a round one, as has been adopted, I understand, on the Pennsylvania Central Railroad. It seems to me that the office of the exhaust being to displace the atmosphere in the stack, and the stack being of a circular form, that the best form for an exhaust tip would be that of the stack; and yet, for some reason, as I have before stated, I believe the Pennsylvania Railroad adopted the other form; and if there are any members here from that road, or any one, that can give us an idea of why it is done, or of the value of doing it, I should be glad to hear from them.

R. H. BRIGGS—This is a question in which we are all interested. The grand secret, I believe, is to obtain as near a perfect vacuum in the smoke-box as possible, and I have always looked upon an exhaust tip as what you might term a pump. The steam, pushing up through the stack, acts as a piston, pumping the air out of the smoke-box, and it seems to me that if you have a round orifice to fill, like the stack, that a round nozzle would be the best to fill it. That has always been my

theory. I cannot see how a rectangular one would be of any greater advantage.

JACOB JOHANN—My opinion on the matter of exhaust nozzles is that it is simply a matter of expediency. I don't see as there can be any very material difference between a round or a square orifice to an exhaust nozzle. What you want is just as Mr. Briggs explains—you want to expel the atmosphere and create a vacuum, so as to draw your fire; and the question is, what device will do that the most effectually is what you want; and without having made any experiments, and not pretending to speak directly from the facts of the case, it is my opinion that it does not really make any difference except in the matter of convenience. Now, you can manipulate a circular orifice with a great deal less trouble than a square one, and for that reason I presume they are made circular; and why some one likes to make them square I haven't inquired into, and I don't see that there is any particular advantage in that form over the circular. In my opinion, what you want of the exhaust pipe is to have room enough to get your steam out of your cylinder as rapidly as possible, and create the proper vacuum for your furnace; and when you do that, that is all you want, and all you can do, in that direction.

M. N. FORNEY—I would like to know what difference there would be in the shape of the exhaust when it comes through the round pipe from what it is when it comes through the square. This discussion reminds me of a dispute I once heard, of some dealers in oil, with reference to why certain oil would not lubricate. One man said that the reason why his oil would not lubricate was that the ultimate particles were globular; and the reason the other man's oil didn't lubricate was because the ultimate particles were cubicle. I don't know exactly who has found out what the form of a current of steam is in a chimney after it leaves the exhaust tip, but if anybody has, I should like to have him produce his evidence. I am open to conviction. If anybody has any evidence to submit on this point, it would be well for us to hear it; but, at present, it seems to me that this discussion, from a merely speculative point of view, is not likely to reach any very useful results.

ANGUS SINCLAIR—I think the draught in the smoke-stack is maintained on the same principle that a current is maintained in an injector, and most of you are perfectly familiar with the manipulation of an injector. I think if Mr. Forney tries a combined tube of a rectangular section, that he will find a most decided difference in the amount of steam needed to raise the water. I think the two are precisely the same. There have been a great many experiments made to see what form of

nozzle and what position of nozzle would produce the best vacuum, and would make steam easiest; and it has been decidedly shown that a round nozzle, about the diameter of the stack below the stack opening, makes a more perfect vacuum for the size of the opening than any other shape. That is not merely an assumption. It is the result of very carefully conducted experiments; and if any of you care to look over the very interesting report of Mr. Martin, in Peru, to this Society, some years ago, you will find a great deal that is interesting and edifying on the subject of exhaust nozzles.

H. N. SPRAGUE—I have never had any experience in this matter. President Lincoln used to complain a great deal about the way in which he got a square man to fit into a round hole, and his experience was that a round man would fit in a round hole better than a square man would. [Laughter.]

E. M. ROBERTS—I think, even if you lay aside the question of any other advantages of the round tip, you find often with a straight stack that it is a very inconvenient thing to clean the nozzle. On some roads many engineers adopt the flat tube tapered with a long handle to it. By inserting that through the top of the stack into the nozzle they can clean the nozzle out in a very few minutes, and if it had no other advantage than that, I certainly think that the round nozzle is worth keeping.

W. H. SELBY—I do not know what shape the steam takes after it leaves the nozzle, but I find just as good results from the round nozzle as any other; and I don't see why it is not about what we want.

N. W. HOWISON—I would state that I have used a square nozzle and a round nozzle. If any members could see our scrap pile, they would find the square nozzles there now. The same nozzles are used to-day on the Baltimore & Ohio Railroad, and I cannot find any difference between the square and the round nozzle. The round one gives equally as good results in my estimation

M. N. FORNEY—I don't want to be understood by this Convention as pre-judging the question very hastily. I am very willing to listen to anything that may be said on the subject. I always listen with a great deal of attention to anything that Mr. Sinclair says; and if he has any evidence to submit in relation to this matter, I should think it important that we have it. The gentleman who has just spoken refers to the square nozzles used on the Baltimore & Ohio road. I might say that I was raised on square nozzles, but up to this time I have never heard why there was any reason for preferring them over the round nozzles. A gentlemen near me says that on the Pennsylvania road they use the square nozzle, because in using it they can be brought nearer the centre

of the smoke-stack. That may be a reason, but merely to speculate about it, I think, is not likely to lead to any sound conclusion.

JACOB JOHANN—While we are on the subject of nozzles, I want to bring up the kindred subject of single and double nozzles. I would like to hear some of the members talk about that, because some think that a single nozzle is the best, and some prefer the double.

THE PRESIDENT—Wouldn't that come up under the five-minute discussions when we are through with this subject?

JACOB JOHANN—Yes, perhaps, it would.

L. M. AMES—I would state, as I have been on a division of the Pennsylvania Railroad, until recently, for twelve years past, that we have been using square and round nozzles on about half of the engines. We have about fifty engines on that division. My experience is that one is as good as the other. We use them both, and both make steam alike. There doesn't seem to be any difference so far as the steaming, or anything else, is concerned. When I say I have been on the Pennsylvania Railroad, I mean on the Northern Central Division.

SECRETARY SETCHEL—I just want to touch on a point that has not been mentioned here, and which has been given to me as a reason why the Pennsylvania road use that kind of a nozzle. I think it doesn't apply with equal force now as it did years ago when engineers were allowed a great deal of latitude in making changes on their engines. As a rule every man had his own engine, and they had their pet smoke-stack, and pet everything about the engine, and they thought as much of her probably as some men do of their wives; but that day is past. At that period, I have had it given to me, in a joking way, of course, that they put in a square nozzle so that the engineer couldn't as readily measure the size of it and want to change it.

[On motion, the discussion on this subject was closed.]

JACOB JOHANN—I now renew my suggestion; I would like to hear what members think about the single and double nozzles. Some use single nozzles, and some use double nozzles, and each think the one they prefer is the best in the world. I am not prepared to enter into any argument about the matter, for I haven't made any practical experiments on the subject to know which is best. If any of the members have had what Mr. Forney says he wants, I would be very glad to hear it.

R. H. BRIGGS—I think Mr. Martin, of Peru or Chili, some time ago furnished a long series of articles wherein he demonstrated the fact tha a double nozzle was of much greater advantage to the engine than a single nozzle. I read the articles at the time they were published, and acted somewhat upon his experience. Yet at the same time, I would like to hear the experience of our members in reference to it.

ANGUS SINCLAIR—My recollection is that Mr. Martin was in Peru at the time he made these experiments. He was a member of this Association, and it was to this Association that the articles were contributed. The articles were contributed for a report, and a very interesting and valuable report it was, perhaps the most thorough ever made on that subject, and the best experiments ever made on that subject. He went very fully into the use of double and single nozzles, and various forms of nozzles. These results were given, I think, in the Fourteenth Report of this Association. It was most decidedly in favor of the single nozzle.

W. WOODCOCK—I think I handed in that report of Mr. Martin's, and it was accompanied with lists and data from careful experiments, and I thought at the time it was a very good illustration of the exhaust nozzle in its various forms. I remember that Mr. Martin said that the "compound" nozzle, as he termed it, was the best; that is, a double nozzle running up to within six inches of the top, and then putting a round nozzle on top of that. From the data that he furnished, I think you will find that the best results were arrived at from the use of that nozzle, and Mr. Boon afterwards conducted some experiments with that style of nozzle. If he were present, he could undoubtedly give us some interesting data.

CHARLES BLACKWELL—I have heard a great many men find fault with the single nozzle. I think that in most cases the complaint is well grounded, it lying in the shape of the nozzle. I have had a good many experiments with single and double nozzles, and one of the first experiments I made with single nozzles gave very disastrous results. I found that the back pressure could be removed by making the two openings, which came from each cylinder at the point of junction with the single pipe, not larger or materially larger than the tip of the nozzle. If you have the area where the two pipes join, each equivalent to five inches in diameter, and the tip four and a half inches, you will have a certain amount of back pressure. If you use a tip four inches in diameter, you will have more back pressure. I found that the best way to get rid of the back pressure was to make each of the openings from the two steam pipes, where they joined together, as near as possible the diameter of the tip.

E. A. CAMPBELL—Will the gentleman please tell us what the size was, both of the double and the single nozzles?

CHARLES BLACKWELL—The experiments which I made were taken with a consolidation engine; and to the best of my recollection the nozzle was four-and-a-half or four-and-three-quarters in diameter in the single nozzle; and each of the two pipes, where they joined the single

pipe, was equivalent to that same diameter—four-and-a-half to four-and-three-quarter inches. The lower casting was, if I recollect right, made so that in case you wanted to use a large tip you could bore it out larger. I am not quite clear on this point, however. The castings were made in such a way that in boring out or bushing, as the case might be, you could make use of the same casting. I had very satisfactory results in getting rid of the back pressure—reducing from twenty-three pounds down to practically nothing.

R. H. BRIGGS—What was the size of the cylinder with which you experimented?

CHARLES BLACKWELL—20x24. I think that the very best results were obtained by lowering the nozzle until it was thirty-six below the top of the smoke box. I could use then the four-and-three-fourths nozzle and get all the steam I wanted. That I could not do with the four-and-a-half-inch nozzle, if it was at the ordinary height below the top of the smoke-box—eighteen or twenty inches; but by lowering the height of that nozzle I was able to get as much steam with an increased diameter of a quarter of an inch, or four-and-three-quarter inch diameter.

(On motion, the discussion of this subject was closed.)

W. E. LOCKWOOD—I now offer this Resolution:

THE PRESIDENT (Interposing)—I don't think a Resolution is in order at present.

E. A. CAMPBELL—I would like to hear a little discussion on the subject of check valve. I see on the railroads down here something new in that respect, where the valve is placed inside of the boiler. I was shown it in New York, and I was told that the Pennsylvania Railroad had adopted that style of check valves.

THE PRESIDENT—Wouldn't it be well, Mr. Campbell, if you specified the difference between the check valve that you are familiar with and the one that you say you have seen here lately.

E. A. CAMPBELL—Well, sir, this check valve which I saw here goes on the inside of the boiler, and it is something that I have never seen before. They told me that it was adopted on the Pennsylvania Railroad. The check valve that I am familiar with is the ordinary kind of check valve.

L. M. AMES—I would state that the check valve referred to, as being in use on the Pennsylvania Railroad is of a very recent date, and in talking with three or four of the Master Mechanics, they don't speak very well of it. I don't think it has been tried long enough so that anybody can say very much either for or against it.

M. N. FORNEY—I do not know whether the members will recollect that at the meeting of this Association held in Providence, some years ago, I had the honor to submit a paper to the Association on this subject of checks, and of perforations in boilers in various ways. The check which is referred to here, I presume is one with which Mr. Hayward, of Jersey City, had something to do. It is placed inside the boiler, and is arranged in such a way that in case of accident, or the knocking off of what projects outside of the boiler, the hot water and the steam will not be permitted to escape. I think the members will recollect a very bad accident which occurred near Pittsburgh, in which the check valve was knocked off, and where seven persons in the car were scalded to death on account of the escape of the hot water and steam from the boiler into the car. This was an accident, I think, where a locomotive crashed into the rear car of a train just in advance. I think it was with a recollection of that accident that the Pennsylvania Railroad authorities have been induced to give this new check valve a test. I was induced to speak again on this matter by motives of humanity. I suppose the members of this Association have no idea of the number of perfectly horrible accidents which occur from the scalding of persons in cases of collision. Some time ago I took the pains to collect all the data I could from the newspapers, and the details of some of them are so perfectly horrible that it seems as though this Association should give the matter especial attention. The evil grows out of the fact that in the construction of locomotives you fill them up full of holes and then screw some sort of a projection into them so that they finally resemble a porcupine. In cases of accident, some of these are almost certain to be knocked off, and the hot water and steam escape and scald the persons in the wreck. Whatever can be done to remedy this thing ought to be done. There is certainly nobody in this country to whom these things appeal more forcibly than they do to the Master Mechanics.

CHARLES BLACKWELL—It seems to me that the mode adopted by Mr. Webb, of the London & Northwestern Railway, in England, overcomes, to a very great extent, the difficulty referred to by Mr. Forney, especially in connection with cases where the check valve is broken off. I presume that many here have seen the drawings showing that Mr. Webb introduces feed-water by means of checks attached on the back head. The water is carried from these checks forward by means of a tube, and thereby they overcome the necessity of mud or scales near the pipe. This plan of attachment reduces the danger referred to very greatly.

THE PRESIDENT—Gentlemen, it is now one o'clock. We close the discussion of five-minute subjects and resume the ordinary order of bus-

iness. There are three motions before the Convention at the present moment.

SECRETARY SETCHEL—I always want to be corrected when I am wrong, and if I make a mistake, I can make proper acknowledgment of it. I do not think there is anybody that is more willing to do so than myself. Previous to this discussion coming up it had been brought to my notice that the name of one of our old members, a man who is respected by us all, and a man who has taken an active part in the early period of the Association, had been omitted from the rolls—Mr. H. D. Garrett, of the Pennsylvania Railroad, and also the name of Mr. H. W. Eddy, a younger member, and I desire to say to those gentlemen that it is a mistake, of course, for which I am very sorry. Now, Mr. President, in regard to the matter of which we are talking—the correction of the minutes—I desire to say to this Association I believe I am able to maintain my position, that the minutes of the last annual meeting of this Association, as printed, are substantially correct. If you will turn to page fifty-one of the Report, you will see that the Convention was called to order by the President, who said: "Discussion on the report of the Boiler Committee is now in order." Then the Secretary said: "As all the members are not here at this time, and as there is a little preliminary business that might be attended to, I would suggest that committees be appointed," etc., etc.; and then Mr. Lockwood said, "I have a communication to present—"

A MEMBER (interrupting)—I thought that question was voted on and laid on the table.

ANGUS SINCLAIR—I made a motion to lay that subject on the table, and it was carried.

JACOB JOHANN—Yes, that was laid on the table; I seconded the motion of Mr. Sinclair.

W. E. LOCKWOOD—I hope that the Secretary will be allowed an opportunity to make his explanation.

SECRETARY SETCHEL—Then, sir, I rise to a question of privilege. I claim the privilege of making a statement in regard to the manner in which, I think, the minutes should be interpreted.

W. E. LOCKWOOD—I move that the Secretary be granted the floor, with the privilege of reply on my part.

THE PRESIDENT—I confess to not being sufficiently familiar with parliamentary rules to know how this matter now stands before the Convention. Will the Stenographer refer to his notes and tell me whether the matter was laid on the table?

[The Stenographer referred to his notes and found that a motion was made by Mr. Sinclair, seconded by Mr. Johann, to lay the whole matter on the table, which motion was put and prevailed.]

JACOB JOHANN—It is the opinion of every member of this Association that Mr. Setchel, as Secretary, has conducted the affairs of the Association successfully, and has reported the proceedings correctly, as far as anybody has known.

G. W. STEVENS—The gentleman is out of order. There is a motion before the Convention.

N. W. HOWISON—I think, Mr. President, that it is right and proper that the Secretary should be heard in his own defense about this matter.

THE PRESIDENT—I think the question should be voted upon whether we reconsider the matter that has been laid on the table, and for that reason I will put the question to the Convention.

[The question was then put upon reconsidering the matter under discussion. The result being in doubt, a division was called, and the motion to reconsider the vote, by which the matter was laid on the table, prevailed. Ayes 32, noes 21.]

THE PRESIDENT—Mr. Setchel now has the floor.

SECRETARY SETCHEL—As I read to you, miscellaneous business was stated by the Secretary, and among that miscellaneous business was an application for Associate Membership. Here is a communication said to be a copy of the original, and from my recollection of it, I have no doubt that the copy is correct, which was handed me by Mr. Lockwood at this time. I remember that there seemed to be a little pleasantry about it, but I didn't anticipate that there was any joke in the matter. The letter heading reads: "Charles T. Perry, President, William E. Lockwood, Superintendent Motive Power, Beach Haven International Trans-Continental & Inter-Colonial Railway. Department of Motive Power."

"BEACH HAVEN, N. J., June 15, '85.

To the President and Members of the Railway Master Mechanics of the United States:

GENTLEMEN:—Allow me to introduce Mr. William E. Lockwood, our Superintendent of Motive Power. We deem it highly important that a road of the magnitude of the B. H. I. N. T. C. & I. C. R. R. Co. should be properly represented at your Convention. Mr. Lockwood is fully authorized to present each member with an annual pass, and to make such arrangements as will afford a full opportunity for examining the great improvements developed under his intelligent management, much

of which will be interesting and regarded in the nature of a new departure. With best wishes to all, I remain,

Truly yours,"

Signed by our friend, "CHARLES T. PARRY, President."

Now, Mr. President, that was presented to me, and I supposed of course, that the gentleman was entitled to membership in this Association. I had no other thought. Perhaps he is now. That is not my province to determine, but I want just to say to the members of this Association that this magnificent road, which the gentleman represents, is about—How long is it, Mr. Lockwood?

W. E. LOCKWOOD—I should think about a mile and three-quarters.

SECRETARY SETCHEL—Now, I think there is no gentleman in this room but what will agree with me that Mr. Lockwood had no more right to become a member of this Association than a man who had never seen a railroad, within the meaning of our Constitution. I don't undertake to say what was the object of obtaining this membership, but I do undertake to say that evidently the gentleman did not expect to be admitted as a member on that ground, and, therefore, when he presents this paper to me, he says: "I have a communication to present, and would place it before the Convention now, that it may be referred to the Committee on Associate Membership, and I will confer with them in relation to it." Expected to be admitted under the head of Associate Membership. I had just said, "I have here a communication for Associate Membership." Now, isn't that a faithful record of the transaction? Is there any recommendation of Associate Membership there? I take it, sir, that there is nothing of the kind. Then the Secretary read what paper? Not Mr. Lockwood's paper; but the paper of Associate Membership that he had before referred to. Is this not correct?

Now, then, in reference to the Smithsonian Institute. I undertake to say that there is recorded on pages 136 and 160 all the communication that I ever received in regard to that matter of the Museum under the control of the Smithsonian Institute. There the gentleman's letter is published. There all the proceedings in regard to it are plainly stated by the gentleman that moved that Mr. Watkins be heard in behalf of it.

Now, as to the complaint that he is wrongly quoted, I contend this is simply a typographical error for which the Secretary ought not to be held responsible. This is not an unusual thing. These things have occurred before. Have they not occurred in some of the best publications of our land? Are they not occurring daily? Mistakes are being made, and they are known to be mistakes, but they are overlooked and taken as such.

I still maintain the ground that I did at first, that we can not undertake to correct what every man says and make it read so that it will just suit him. Why, we would be called upon to correct and modify the statement of a man who followed him to make it correspond with his remarks, if we did that.

These reports are valuable. I admit it. And they will be more and more valuable in the future; but I want to say if every member of this Association was reported actually verbatim, the best men in this Convention would oftentimes hate to see their language as they actually spoke it. This is all I have to say upon this matter, but I still contend for what I said at the outset, that the report is substantially correct, and as correct as publications of the kind generally are, and I challenge the contrary.

W. E. LOCKWOOD—I am very glad that the Secretary has taken this opportunity to make this statement, because it affords me an opportunity to put myself straight upon the record. When I presented that communication, it was true, not being familiar with the rules or proceedings of the Association, that I did expect it would be referred to the Committee on Associate Membership, because I had been requested by members to associate myself with this organization as an associate member. I presented that letter to the Secretary, who presented it to the President. There was a recess taken in which I was asked to come to the platform. The President read that letter, and he said: "It is a short road, but it might grow."

THE PRESIDENT—I must dispute that statement at once, for I did not know the road represented until after the Convention.

W. E. LOCKWOOD—Did not the President attend the Convention the year before and ride over the road?

THE PRESIDENT—That may be; but I did not know the name of the road.

W. E. LOCKWOOD—Taking the explanation of the Secretary in any connection in which you can put the English language, it naturally follows as a sequence that that paper there presented was the one. I wrote the Secretary and said that after I had made some remarks upon Spark Arresters, I discovered that I had made an error; that the gentleman had handed me a paper in haste that said that the grade of a road was four feet to every one hundred feet, instead of four feet to the mile, and I asked him to return to me what the shorthand reporter had written, and I would try and put in the correction. I received the most miserable piece of type-writing work I ever saw in my life, and attempted to decipher and correct that statement, and the Secretary printed it after I had corrected it. Now he says that this is substantially correct.

The resolution which Mr. Lauder offered, and which was passed, can be found in the Chicago Railway Age and Review, but it is not among the Minutes of this Report.* There is another thing, and that is in relation to the statement which I made as appearing on page 157. That is the one which I have referred to, which I have just spoken of.

There is another one in which the word "location" is substituted for the word "translation;" that is an error that don't make sense. Now, sir, I am very glad that this matter has been brought up. I do not mean that any member of this Association shall be second to myself in the efforts I shall make to make this Association what I believe it ought to be; and if this discussion has accomplished nothing else, it has shown that we will have correct reports, with all respect to the Secretary's intention to make them so. I disclaim any intention to reflect in any manner upon the Secretary. The only object I have is to have the reports correct when they are read by scientific bodies in this country and elsewhere. I want to see 10,000, yes, 25,000 copies of these reports printed by the Government of the United States and sent out to locomotive engineers all over the country. Now, I will ask, after this discussion is finished, to offer a resolution to that effect, to which no man hearing me dare oppose his vote.

SECRETARY SETCHEL—Didn't the gentleman say in the outset that he was quoted as recommending the associate membership, when he was not a member? I ask him if that was not the burden of his complaint.

W. E. LOCKWOOD—That is what I said.

SECRETARY SETCHEL—There is not a word about it in the report.

W. E. LOCKWOOD—Will the Secretary read page 51?

"Mr. Lockwood—I have a communication to present, and will place it before the Convention now, that it may be referred to the Committee on Associate Membership, and I will confer with them in relation to it." "The Secretary read the paper, which was the application of Robert Grimshaw for associate membership."

SECRETARY SETCHEL—That doesn't refer to your paper at all. It refers to the paper which the Secretary had in his hand talking to the Convention, and the Secretary then read it, and it is a very great stretch of a man's imagination, and it fully describes the feelings that have animated the gentleman, by construing it in that way.

N. W. HOWISON—I move that the minutes of the Convention of 1885 be accepted by this Convention.

ANGUS SINCLAIR—I second the motion.

NOTE.—This Resolution which the gentleman says was omitted will be found on page 160 of last Report.—SEC.

W. E. LOCKWOOD—I move to amend that motion by asking that the minutes be received with the corrections that I have indicated.

D. O. SHAVER—I second that amendment.

[The question was then put upon the amendment and the same was lost. The question then recurring on the motion to accept the minutes, as printed, the minutes were accepted, there being only one vote in the negative.]

G. W. STEVENS—Is there any business before the Convention?

THE PRESIDENT—Yes, sir; the report of your own Committee.

G. W. STEVENS—I will ask that the paper referred to in this report, which was submitted by Mr. Bell, be read by that gentleman.

THE PRESIDENT—You mean that Mr. Bell read the whole of your report.

G. W. STEVENS—No, sir; that he read the paper referred to in the report, which was written by him, that it be read by him in person instead of the Secretary.

SECRETARY SETCHEL—The gentleman has spoken to me and asked the privilege of reading his paper, which the Committee have incorporated in their report as a part of it, and I would be very glad to have him read it.

THE PRESIDENT—There being no objection, Mr. Bell will read his paper.

[The reading of the report of the Committee on "Improvements in Boiler Construction" was then begun. Pending the reading of the same, the hour of adjournment arrived, and, on motion of H. N. Sprague, the Convention adjourned until to-morrow morning, June 16th, at 10 A. M.]

SECOND DAY.

President Barnett called the Convention to order at 10 A. M.

THE PRESIDENT—The regular order of business is the continuation of the reading of the report of the Committee on "Improvement in Boiler Construction."

J. N. LAUDER—Mr. President, I have a resolution that I desire to present at this time, if consistent with the rules.

THE PRESIDENT—Shall the gentleman have leave to introduce a resolution at this time?

MR. BRIGGS—I move that permission be granted.

Carried.

MR. LAUDER—"Whereas, the Constitution provides that only those who are duly qualified shall remain members of this Society, and, Whereas, W. E. Lockwood is not and never has been so qualified under the true meaning of the Constitution, it is therefore Resolved that the Secretary be instructed to take his name from the list of members of this Association."

E. M. ROBERTS I move that the resolution be adopted.

CHARLES BLACKWELL—I second the motion.

W. E. LOCKWOOD—I expected my friend Mr. Lauder would at least give some reason why he offers the resolution, and if it is the sense of this organization that I shall be put out, I bow with due respect to the will of this Convention.

J. N. LAUDER—I believe the motion before the house is the adoption of this resolution. The resolution speaks for itself. I will read it again. It is simply because Mr. Lockwood is not and never has been qualified to become a member of this Association.

[The question then being on the adoption of the resolution, it was unanimously adopted.]

J. N. LAUDER—I now move that we proceed to the regular order of business.

]The motion was seconded and carried.]

The reading of the report was then continued, and at its conclusion, on motion, the same was adopted.

To the American Master Mechanics' Association.

GENTLEMEN: Your Committee on Improvement of Locomotive Boiler Construction respectfully submit the following as the result of their labors. With a circular of inquiry sufficiently broad to embrace the most minute improvement, and giving admittance to any and all boilers, your Committee regret that very few replies have been received. Mr. J. Davis Barnett furnishes an admirable six-page paper on anthracite and bituminous coal burning, from an economical point of view. Mr. J. Snowden Bell furnishes an exceptional interesting paper of thirty pages on improvement in locomotive boiler construction, illustrating with figures 1 to 13 inclusive and plates "A" and "B," with special reference to enlargement of grate area to reach a minimum consumption of fuel, and the utilization of waste or refuse fuel. Both papers are particularly interesting, will repay careful perusal, and your Committee request that they be read before the Convention and embodied in their report.

Mr. G. W. Stevens writes your Committee that his company have had built by the Schenectady Locomotive Works three 18 x 24 inch cylinder 5 foot 6 inch driving-wheel passenger engines, with boiler carrying 180 pounds working pressure. [See Plate 14.] As the engines have only been in service a short time nothing definite can be said of the benefit of the high steam pressure. No trouble whatever is experienced with the valve and cylinder surfaces, and evidence is given of a fuel record that will not exceed five pounds of coal per car mile, with trains of ten cars, equal to 280 tons, exclusive of load, running on a schedule time of thirty-seven miles per hour.

Mr. William Woodcock writes that nothing new has occurred in his practice during the past year, but gives sound advice in advocating steel as the best material for boilers, and with the present tendency to larger boilers, better workmanship, and abhorrence for that instrument of boiler torture known as the drift pin.

Mr. Thomas Twombly reports progress in larger boilers and heavier material.

Mr. Johann. Nothing new.

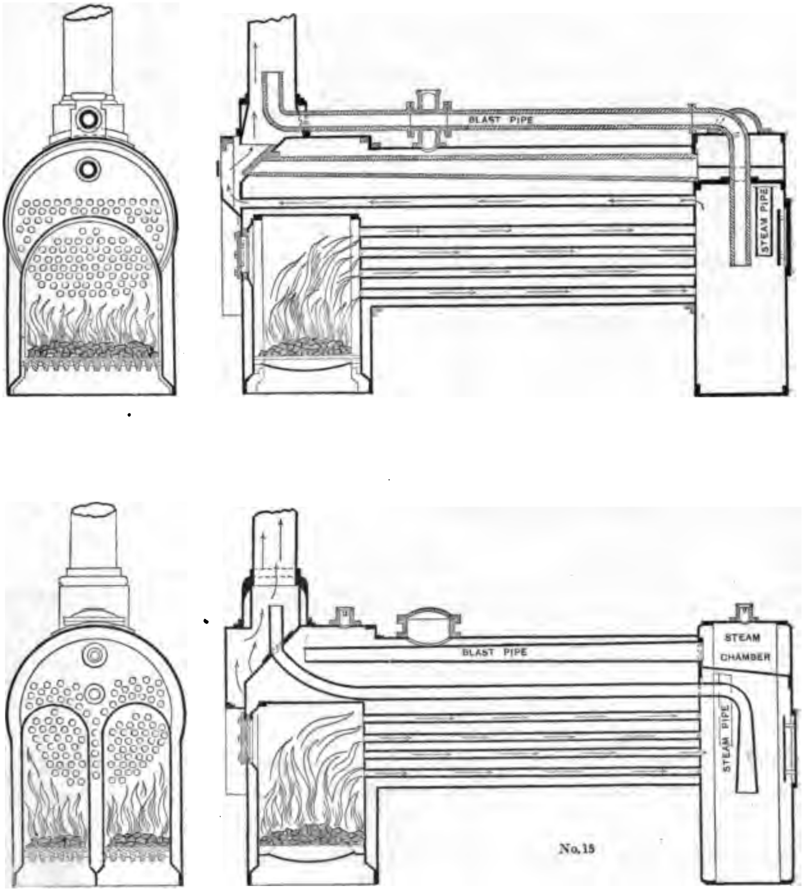
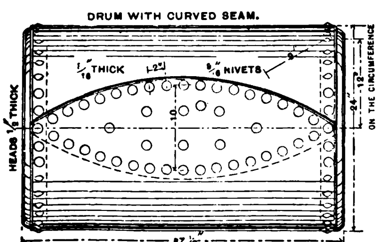
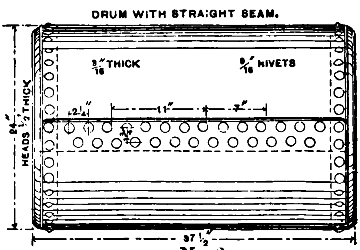


Plate 15.



No. 1

16



No. 2

Plate 16.

CURVED SEAM

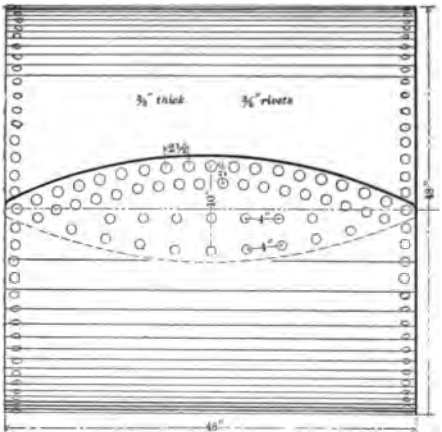


Fig.3

No.17

CURVED SEAM

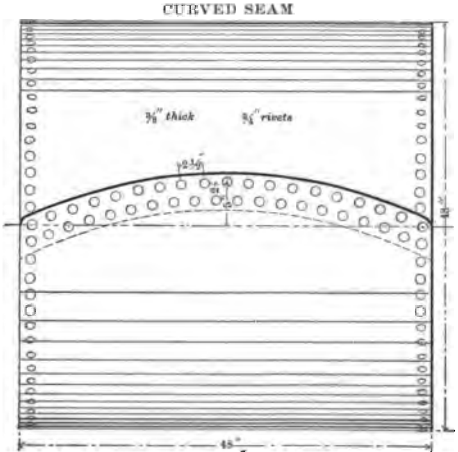


Fig.4

DIAMOND SEAM

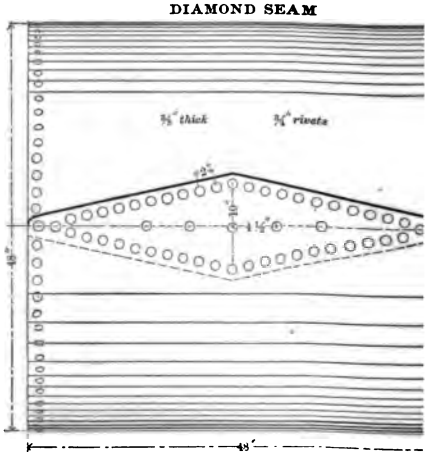


Fig.5

Plate 17.

LETTER OF J. DAVIS BARNETT.

In reply to circular I can contribute but a small item, being a comparison of first cost and maintenance between boilers using anthracite and bituminous coals as fuels; my thanks being due to T. N. Ely, E. Altoona, and F. W. Wooten, Philadelphia, who in 1884 kindly supplied me with the results of their extended experience for a communication on "The American Anthracite Locomotive" read before (and at the request of) the "British Association for the advancement of license" when they met for the first time on this continent, and upon which communication this statement is largely based.

The cost and weight of boilers designed by Mr. Ely for fairly similar work, but adapted for each class of fuel, was then as follows:

BOILER.	COST IN $.	WEIGHT IN LBS.
Class "B" Bituminous	1,225	13,393
Class "C" Anthracite	1,350	14,236
Increase	$125 or 10.2 p. c.	843 lbs. or 6.3 p. c.

Mr. Wooten's opinion was that there need be no marked difference in first cost or weight of ordinary locomotive boilers for these fuels, and gives the life of a steel fire-box burning bituminous coal at 250,000 miles, or say ten years, that of one using anthracite at 200,000 miles or eight years, a shortening of 20 per cent., while Mr. Ely gives anthracite fire-boxes only six years average life, which (if based on the same yearly mileage of 20,000 per annum) makes the reduction 40 per cent.

In the matter of repairs Mr. Wooten said "until within the past eight or ten years the wear and tear and consequent cost of repairs of anthracite-burning furnaces exceeded that of bituminous-burning locomotives to an extent of about 30 per cent. More recent improvements have, however, considerably reduced this disparity, and there is now but little difference in the required lay-off time for furnace repairs," and Mr. Ely says, "as near as we can approximate, the cost is about 30 per cent. in favor of bituminous, the number of days 'laid off' however, being about the same."

To make a cost comparison, say to cover a period of twenty years, which may be accepted as the average life of a boiler-shell,

it will be necessary that we take into consideration both the amount and value of the fuel used and the number and cost of furnace renewals.

The soft coal burner will (approximately) need a second fire-box and the hard coal a third, which allows average lives of ten years for soft and $6\frac{2}{3}$ for hard coal. At present date the cost of taking out old and putting in a new steel fire-box (of about size "B") if good machine tools and hydraulic riveting and flanging is fully used, is $545 net.

Taking it for granted that "C" could be renewed at same cost (and the difference would be a very slight increase) this makes what should be called the capital expenditure on each boiler during its total life, $1,770 for soft and $2,440 for hard-coal burners.

Granting an average annual consumption of soft coal of 1250 long tons (equal to twenty miles per ton) and its price on tender $3 per ton, the outlay for fuel would be $3,750 per annum. Careful and conclusive experiments have proved that hard coal has in locomotive practice but an average evaporative efficiency of 80 per cent. of good soft coal well handled; therefore, it is necessary that hard coal be but $2.37 per long ton, so as each year to leave on fuel cost sheet, after the purchase of $1562\frac{1}{2}$ tons of hard coal, an unspent balance of $33.50 to the credit of renewals (as distinguished from repairs) on hard-coal burner. And if satisfactory soft coal can be purchased at $2.00, then hard would have to be but $1.57 per ton to justify its use, viewed purely from the point of money outlay.

The above ignores the complicated item of interest on capital as it would unduly lengthen and confuse this statement, and its introduction would result only in the lowering of the price of hard coal a fraction.

It also takes for granted—which I do not think will be disputed—that the *running repairs* for the twenty years over two soft coal fire-boxes will about average those on the three hard-coal burners.

Although no railway audit that I am familiar with would actually permit its renewals of fire-boxes to be charged against capital account, nevertheless to get at any comparative values—such as we desire—it is necessasy to so treat it, or else get it so mixed up with general and daily repairs that it would not permit of being

discussed to any definite end. This will appear the more clearly if the attempted comparison was between a wood burner with its single furnace of twenty years' life and whose first cost would be the actual capital expenditure in full, all outlay in following years being simply running repairs. J. D. B.

IMPROVEMENT OF LOCOMOTIVE BOILER CONSTRUCTION.

A history of the art of locomotive boiler construction, comprehending the many modifications of and the few radical departures from the ruling features of the multitubular boiler of Stephenson's "Rocket," which, in 1829, first demonstrated the peculiar fitness, if not the exclusive adaptability of this type for railroad service, would far exceed the admitted compass of a paper in which a review of past practice can be neither interesting nor profitable, further than as it may serve to indicate the essential capabilities of a locomotive boiler, which will satisfactorily comply with the requirements of the present and the proper direction of the line of effort, by which those requirements may be fulfilled. The record of the past needs, therefore, to be but briefly and generally stated, and the incompleteness of its presentation may be passed over in view of its lack of present practical value.

The form of locomotive boiler, which first achieved an actual success in practice in the United States, and was for a long time thereafter used almost exclusively, was of the type designed about 1829, by the English builder, Bury, of Liverpool, its leading characteristic being a semi-cylindrical fire-box, the outside shell of which was worked at its top into a hemispherical dome of corresponding diameter. The dome-top fire-box was immediately adopted by the American builders, and it soon became and for a long time remained the standard of general practice. The early engines using wood fuel almost universally and being of comparatively small capacity, the limited amount of grate area obtainable in boilers of this construction was not, during the early period of their use, considered to be a material objection. The necessity for an increase of grate surface, indicated by the experiments made in the burning

of anthracite coal, developed the present rectangular fire-box, which soon began to displace the original semi-cylindrical form, the earliest instances being a rearward extension of the fire-box beyond the old half round dome.

Figures 1 and 2 show a boiler of this type as applied in the early six-wheel engines, having a single pair of driving wheels, which in the Norris engines were placed in front of the fire-box, and in those of other builders usually behind it. The boiler illustrated, in dimensions and proportions, may be taken as fairly representing those generally used with about 10x18 inch cylinders, there being 121 one and a half inch tubes, 6 feet 4 inches long in a 39½ inch shell, and a fire-box of about 8 square feet, grate area. These boilers were usually made of $\frac{5}{16}$ inch iron and worked at about 95 pounds pressure.

As early as 1839, anthracite coal was burned with tolerable success in boilers of this form on the Hazleton and Beaver Meadow Railroads, and in the same year a committee of the Franklin Institute reported as entirely satisfactory the performance of an Eastwick & Harrison 12x18 inch engine with a similar boiler, also burning anthracite coal, a load of 265 tons being hauled over a 35 foot grade, with steam blowing off at 90 pounds during the entire run. These engines were claimed to steam freely and to have been benefitted in this particular by subdividing their exhaust, which was done either by discharging it into a chest from which it escaped through a number of small pipes, or into what was called a "gravel box," being a chamber filled with small stones, which acted to effect a more continuous discharge of the exhaust steam.

Vertical boilers have been used to so limited an extent as to be worthy of notice, only by reason of their early introduction and the originality evinced by so radical a departure from the usual practice. The first boiler of this type applied to a locomotive, was that of the engine "York," built by Phineas Davis, of York, Pa., for the Baltimore & Ohio Railroad in 1831, in successful response to the first proposal ever issued in the United States for locomotives, which was made in an advertisement by that company, January 4, 1831. The boiler of the engine "Atlantic," built by Davis, in 1832, was 51 inches diameter and 69 inches high, with 282 tubes

of $1\frac{1}{2}$ inch diameter at bottom and $1\frac{1}{4}$ at top, and a grate area of 11.79 square feet. The cylinders of the engine were 10x20 inches and exhausted into the casing of a fan blower which forced a blast of air into the ash pan. The steam pressure was 50 pounds. Boilers of similar construction but larger dimensions were subsequently built by Ross Winans, although not to any large extent, and in a few instances by others. Seven engines with vertical boilers were built by Ross Winans, for the Western R. R. of Massachusetts, in 1842. These engines weighed from 20 to 23 tons, on eight driving wheels thirty-three inches in diameter. The grate area was 24 square feet and their consumption of anthracite coal was reported as $2\frac{1}{2}$ tons per trip of 100 miles. Plate No. 2, Fig. 3, taken from the patent of Ross Winans, No. 308, of July 29, 1837, illustrates this form of boiler as made by him, and embodies the principal features of the type as first applied by Davis. This type of boiler worked successfully, and some few of them are still in use, but its incapacity for enlargement to a sufficient degree to answer the increasing requirements of railroad service, prevented it from becoming an element of standard practice.

The earliest instance of a material increase of grate area, other than in the vertical boilers above noticed, as well as of the employment of a return tubular boiler in a locomotive, is presented in the boiler of the engine "Novelty," built in 1846, at the Reading shops of the Philadelphia & Reading R. R. Co., from the designs of G. A. Nicolls, then Engineer and Superintendent of that road.

Plate No. 3, Fig. 4, a longitudinal section, and Plate No. 4, Fig. 5, a transverse section of the boiler of the "Novelty," are reproduced from the drawings of Mr. Nicolls' patent, No. 5787, of September 19, 1848. The fire-box, the grate area of which was 36 square feet, extended for about 10 feet under the barrel of the boiler and the products of combustion passed to the stack through 100 tubes, $2\frac{5}{8}$ inches in diameter and 14 feet long. The total heating surface was 1085 square feet. The boiler was on a separate carriage from the cylinders, which exhausted into a condenser and drove a blower discharging into the ash-pan.

The performance of the "Novelty" was not satisfactory,

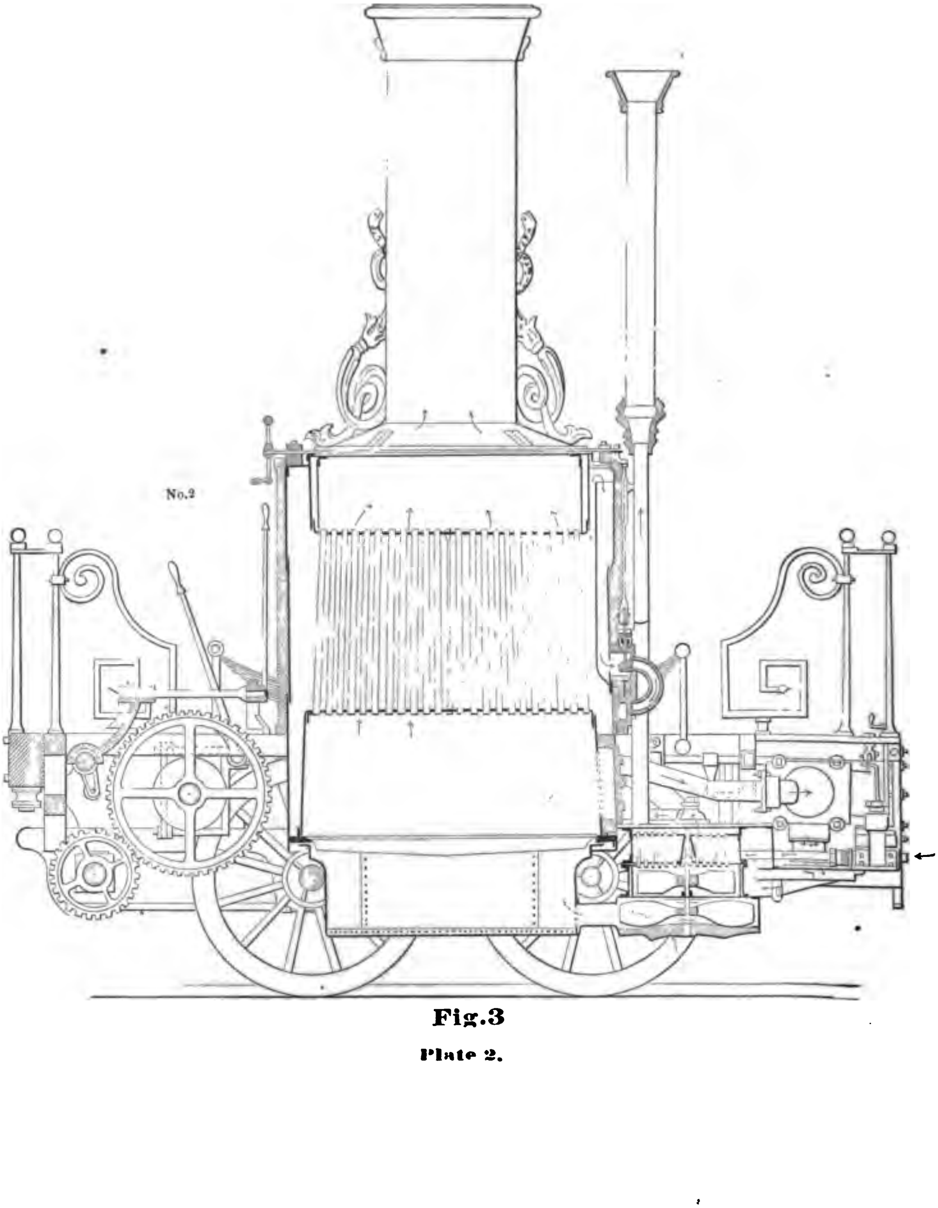


Fig.3

Plate 2.

Fig.4

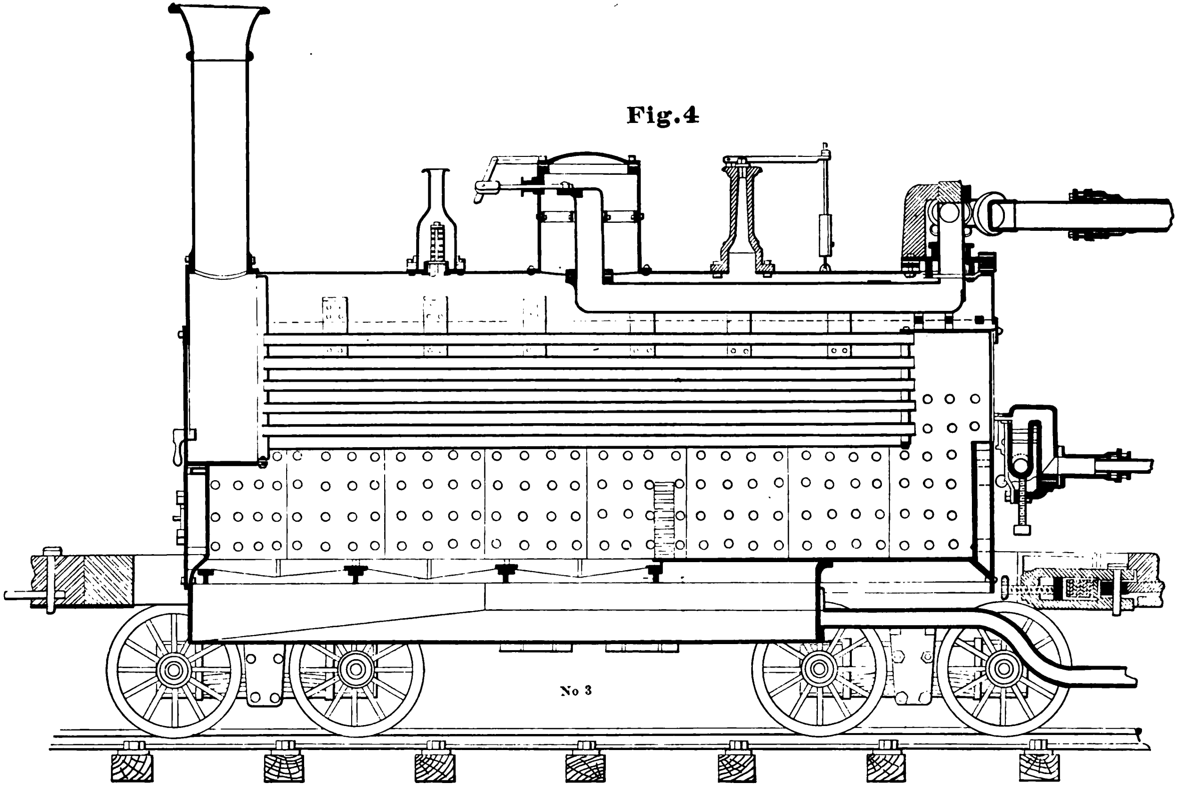


Plate 3.

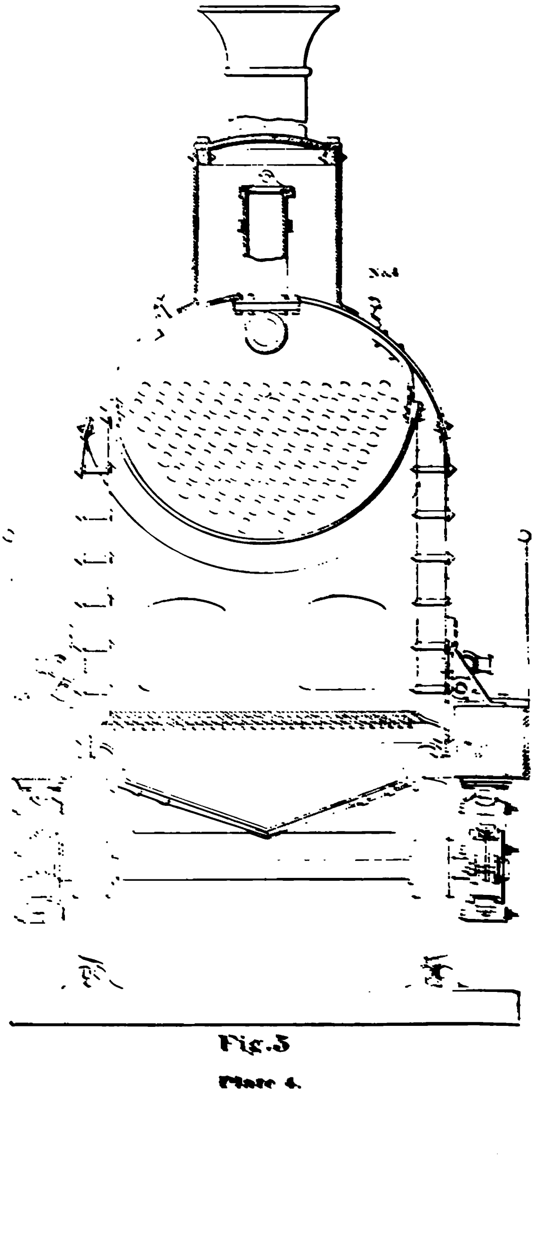


Fig. 5

Plate 4.

although the boiler was much larger and more powerful than any that preceded it. The engine did not continue long in service, its total mileage having been only 21,510. Major G. W. Whistler, in a report on the use of anthracite coal in Locomotive engines, made April 20, 1849, characterized the engine as entirely impracticable and noted the fact that its fuel consumption was nearly fifty per cent. greater than that of other engines doing the same duty, this being due to condensation and leakage in the pipe leading to the cylinders, and to the percentage of steam required to drive the fan, and no other application of the return tubular boiler in locomotives was made, until the construction of one of that type under the Coventry Patents in 1884, a report of experiments with which on the C. R. I. & P. R. R will be found in the proceedings of the Eighteenth Annual Convention of the American Railway Master Mechanics' Association, pp. 46, 47.

As before stated, anthracite coal had been burned with some measure of success in boilers of the original dome-topped half-round fire-box type in 1839, but subsequent attempts to use that fuel in similar boilers, but under different conditions of service, did not give satisfactory results and demonstrated an increase of grate area to be essential. It is probable that the first practically successful coal burning engines with horizontal boilers, were those made by Ross Winans, for the Baltimore & Ohio R. R., the first of which was placed on the road in October, 1844. In these boilers, the fire-box was increased in size and made of rectangular form, extending slightly backward beyond the dome, and having a grate area of $13\frac{5}{16}$ square feet. These engines had 17x24 inch cylinders and weighed $23\frac{1}{2}$ tons, on eight driving wheels, 33 inches in diameter, which were driven by gearing, and their consumption of bituminous coal, taken from an average of thirty trips made between Harper's Ferry and Cumberland in 1848, was $2\frac{1}{2}$ tons in a run of 98 miles, with a gross load of 275 tons.

A further enlargement of the fire-box, by its increased rearward extension, was made by Winans in four anthracite coal-burning engines, built by him for the Philadelphia & Reading R. R., in 1847. The boilers of these engines were 42 inches in diameter, with $2\frac{5}{8}$ inch tubes, 14 feet long, 18 square feet grate area and 957

square feet of heating surface. The form of their fire-box with upper and lower furnace doors is shown in Plate No. 5, Figs. 5a and 5b.

The leading characteristic of the Winans boiler, its large proportion of grate area, reached its final development in the well-known "camel" engine, many of which were built for various roads from 1852 to 1860. The longitudinal extension of an overhung fire-box having the greatest width admissible between the driving wheels, was carried out in these engines to a degree never before, and in fact never since, attempted. The grate of the earlier engines was 7 feet long, by 3 feet 6 inches wide, giving an area of 24½ square feet, and, to reduce as far as possible the overhanging weight, the top of the outside fire-box, which was flat, was downwardly and backwardly inclined, and the crown sheet was similarly inclined and connected to the outer shell by stay bolts, the intermediate space being contracted to about 3 inches and no crown bars or crown stays, properly so called, being used.

This construction was substantially similar to that subsequently introduced in Europe and reproduced to a slight extent in the United States, under the name of the "Belpaire" fire-box. The dome and the house for the engine-man were located on the forward part of the waist to assist in balancing the weight of the fire-box, and two feed hoppers or shutes were placed on its top. The last design of these engines constructed, which were termed "long furnace camels," is shown in section, in Plate No. 6, Fig. 6, reproduced from the *Railroad Gazette* for September 23, 1881, and in these, as will be noticed, the furnace, which had been increased to a length of 8 feet, was supplemented by a short combustion chamber, formed by an upward and forward inclination of the front water leg. With all the defects of the camel engines, which will be remembered by those who were familiar with them as numerous and serious, they did good service in their day, steaming freely and having great tractive power from their large cylinder capacity and utilization of their entire weight for adhesion.

The excessive length of the furnaces of the camel engines, being considered by many a substantial objection, attention was next directed to the increase of grate area, by extending the fire-box

Fig. 5b.

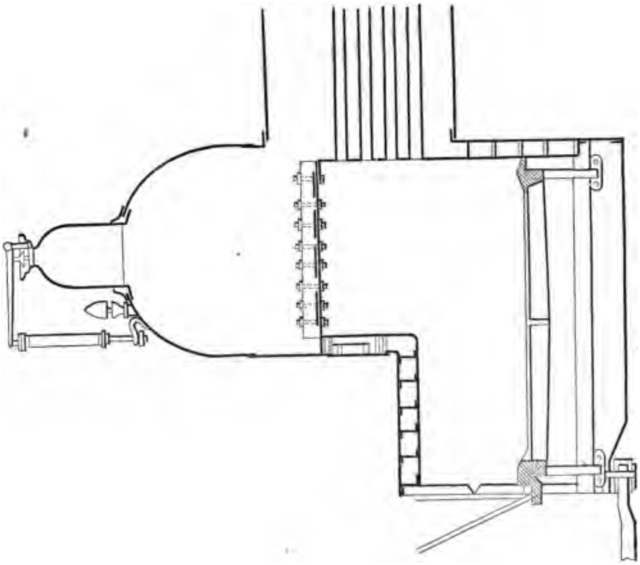
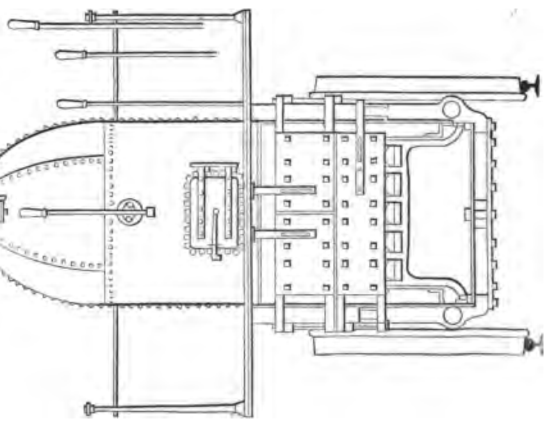


Plate 5.

No. 5

Fig. 5a.



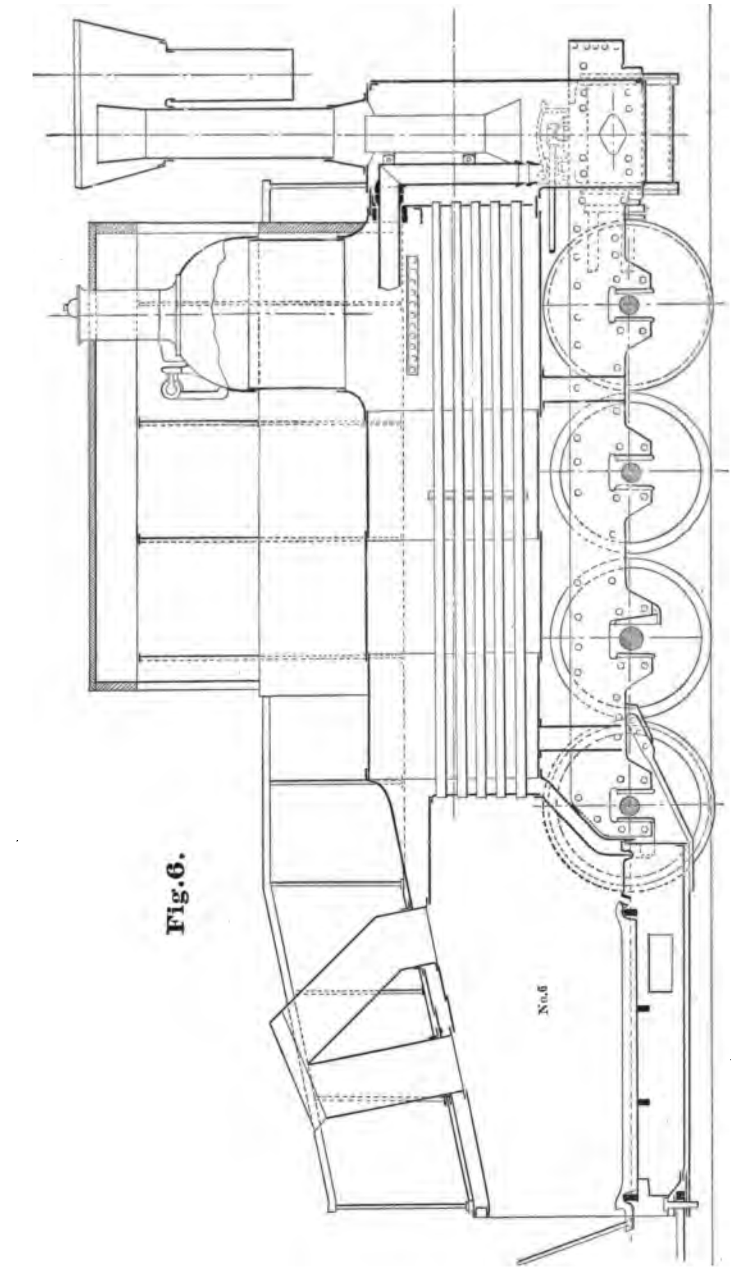


Fig. 6.

Plate 6.

laterally behind the driving wheels, and boilers of such construction were designed and applied about 1852, by James Milholland, Master of Machinery of the Philadelphia & Reading R. R., in a number of anthracite coal-burning freight engines, having six driving wheels and a pair of small leading wheels, which were built in the Reading shops of that company. Overhung fire-boxes of similar construction were also used in the boilers of engines built for 6 feet gauge roads, by the New Jersey Locomotive Works in 1854, these fire-boxes being 7 feet 6 inches wide inside, by 6 feet long, thus affording the large grate area of 45 square feet. The form of this fire-box in transverse section is shown in Plate No. 7, Fig. 7.

Fig.7

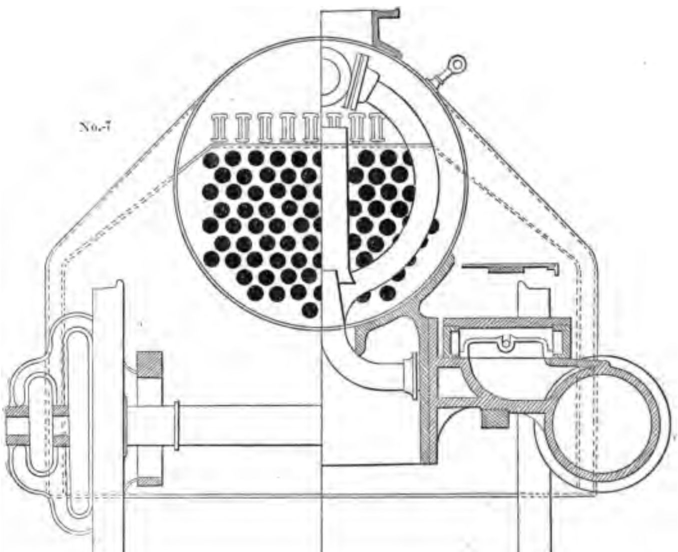


Plate 7.

It differed from the Milholland fire-box, in having the lower portion of its side water legs vertical, while those of Milholland were continuously inclined from the waist of the boiler to their lower ends.

The Dimpfel water tube boiler, which was designed about 1849, was adopted by the Taunton Locomotive Works in 1853, and built by them to a limited extent for some years thereafter. Its performance was at the outset apparently satisfactory, but extended service developed inherent defects, which prevented it from meeting with general favor and its manufacture was soon discontinued. Several engines with boilers of this construction were built by the Taunton Locomotive Works, for the Philadelphia, Wilmington & Baltimore R. R. in 1857, one of which. the "Daniel Webster," was reported to have hauled 120 tons at 30 miles per hour, with a fuel consumption of 26.02 pounds of bituminous coal per mile, and an evaporation of 8.78 pounds of water per pound of coal, a performance which was exceptionally excellent, if representing the continuous duty of the boiler in regular service, which would not however seem to be the case, as its use was abandoned upon that road, and its manufacture has not since been resumed by its original or any other constructors.

The engine "Taunton" with a Dimpfel boiler was placed on the Philadelphia & Reading R. R., in July, 1855. The sedimentary deposit upon the inside of the tubes of the boiler was found to interfere as seriously with the circulation, and add so materially to the cost of maintenance, that its use was discontinued after a service of three years.

The distinctive feature of the Dimpfel boiler, as shown in Plate No. 8, Fig. 8, was a series of water tubes, which curved downwardly from the crown sheet and extended horizontally to a water space at the smoke-box end of the waist. The products of combustion passed around the outside of the tubes and into the smoke-box, by an outlet at the bottom of the waist.

The Boardman boiler was built for a few engines at about the same time as that of Dimpfel, and similar excellent results were claimed for it, but it made a still briefer record, that may be readily accounted for by its involving a complicated and expensive construction, which may be understood from Plate No. 9, Fig. 9, without any apparent advantage in return. The fire-box was of the ordinary rectangular type, and a single flue divided by a transverse partition extended through the waist. The tubes were vertical and

located in a flat-sided casing below the waist, which was heavy and expensive, and required an elaborate system of stays.

The Phleger boiler, shown in Plate No. 10, Fig. 10, was patented by Leonard Phleger, March 11, 1856, and was applied for a few years thereafter, on a number of engines burning anthracite coal, built by the Norris Locomotive Works, of Philadelphia. Its prominent features were a combustion chamber, separated by a water-bridge wall from the fire-box, a hanging water wall extending downwardly from the crown sheet, between the water bridge and the flue sheet, and water grates. The waist of the boiler was filled with tubes and the steam chamber was formed above it. This boiler, while embodying some features of merit and value, never received general acceptance, and soon disappeared entirely from use.

The Phleger boiler was the last of the early constructions, differing materially from the standard type, which type was, for a long time afterwards, modified no further than as to minor features of detail and increase of dimensions, more particularly those of the fire-box, the necessity of providing a larger area of grate and heating surface for burning coal with even approximately satisfactory results having become generally acknowledged, and the advantage of such increase decisively demonstrated in the excellent steaming qualities of the camel boilers, which have been before referred to. The first substantial step in this direction, and one which is worthy of attention from its recent revival and general adoption in the boilers of engines of large cylinder capacity, designed for fast and heavy surface, was made by James Milholland, of the Philadelphia & Reading R. R., in the engine "Vera Cruz," built by him for that road in 1859. In this engine, as shown in Plate No. 11, Figs. 11, 12, and 13, the fire-box was extended longitudinally backward, over the rear driving axle, and laterally by being widened to a distance equal to the width over frames, on top of which it was placed, with two ash pans, one in front of and the other behind the back axle. It was substantially of the Winans type in that it sloped downwardly from the waist to its rear end, but had an arched instead of a flat top. This engine weighed 56,450 pounds, and had 15x20 inch cylinders and 5 feet 6 inch driving wheels. It

Fig.10.

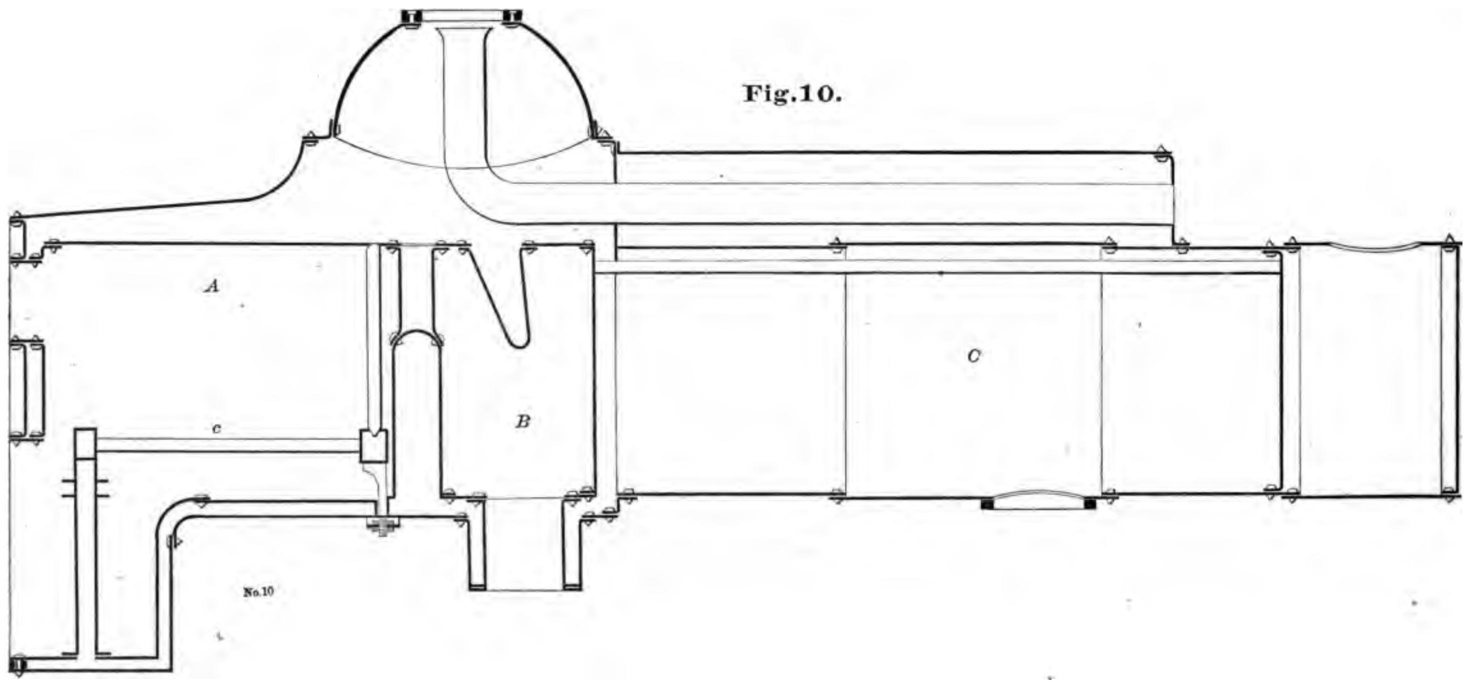


Plate 10.

burned anthracite coal with such success in passenger service, that many other boilers of the same type but of larger dimensions were constructed and are still in use on the same road. The firebox, which was furnished with a water grate of fourteen 2 inch tubes, was 7 feet long by 3 feet 6 inches wide, giving a grate area of 24½ square feet, and was of $\frac{5}{16}$ iron throughout, except the flue sheet which was ⅜. The waist of the boiler was 40 inches in diameter and contained 170 tubes, 11 feet 5 inches long, of which 160 were 1¾, and ten 1½ inches diameter.

The Milholland fire-box remained the standard of the Reading road until 1877, and in 1881 the Baldwin Locomotive Works adopted its leading features in the boilers of six heavy anthracite coal-burning engines constructed by them for the C. R. R., of N. J., for fast passenger service. These engines weighed 93,000 pounds, and the cylinders of four of them were 18x24 inches, and of the other two 19x24. Their boilers of ⅜ iron, were 52 inches in diameter, with 200 two-inch tubes, 11 feet 5⅞ inches long. Their grate area was 38 square feet, and total heating surface 1,320 square feet. Steam pressure, 140 pounds. The fire-box differed from Milholland's in having the ordinary wagon top, instead of a downward and backward slope.

A similar fire-box to that of the Jersey Central engines, having 34.8 square feet of grate area, was adopted in the Pennsylvania R. R. Class "K" engines, the first of which, No. 10, was built in 1881, and the system has probably been carried out to the extreme limit of extension which is possible with the fire-box located between the driving-wheels, in a boiler built by John Campbell, M. M. Lehigh Valley R. R., for a 20x24-inch cylinder anthracite coal-burning passenger engine weighing 97,500 pounds. This boiler is illustrated and described in the Eighteenth Annual Report of the American Master Mechanics' Association, 1885, Plate 41, pp. 107, 108, and its fire-box extended longitudinally and laterally above the frames in the manner of Milholland's, is 10 feet 9 inches long inside, by 3 feet 6½ inches wide, giving a grate area of 38.13 square feet.

It is obvious that the greatest practicable longitudinal extension of a fire-box, being the distance over which coal can be fired ef-

fectively from an end door, and the maximum lateral extension obtainable by placing the fire-box above the frames, which cannot exceed say eight inches, have been fully attained in the boilers last referred to.

The Wootten boiler, which was designed by John E. Wootten, General Manager Philadelphia & Reading R. R., and patented by him July 3, 1877, presents the first and only instance of a material increase of grate surface by lateral extension of the fire-box, which is in such form as not to impose restrictions upon the location of the driving-wheels, and which is, therefore, equally applicable to all existing classes of locomotives, irrespective of the design or proportions of their working and running gear. The first boiler of this class was built at the Reading shops of the Philadelphia & Reading R. R. for an 18x24 ten-wheel engine, No. 408, of that road, which was put in service January, 1877, and the total number in use and under construction at this time aggregates about 315, in locomotives of all the standard types, from four-wheeled shifting engines to the largest and most powerful consolidation and fast express engines that have yet been constructed. The duration and character of the service which has been performed by this boiler since its introduction, are such as to demonstrate beyond question its capabilities as a steam generator, both in free and abundant steam-producing capacity and in economy of fuel, and it now holds an established position as the leading exponent of advanced practice in locomotive boiler construction, notwithstanding the conservative sentiment which, in view of its wide departure from precedents, has imposed upon its general acceptation, the delays incident to careful individual investigation and renewed experiment on the part of those who have adopted it. The original object of its design was to effect the utilization of what was at that time a useless product, namely, the "buckwheat," or finely divided waste produced in the mining and preparation of anthracite coal for the market, as well as other low grades of fuel not previously available for use in locomotive fire-boxes. This having been successfully accomplished, its free steam generating capacity rendered it specially desirable in fast and heavy service, for which it has been employed with both anthracite and bituminous coals, and it has

done and is doing effective and economical duty with a variety of different fuels, among which are included lignite, containing 20 per cent. of water, and the refuse or "sparks," so-called, which is drawn through the tubes and taken from the smoke-boxes of bituminous coal-burning engines, the latter being a product which it is well known is otherwise not only utterly useless but a source of expense for its removal.

The special structural features characterizing the Wootten boiler, the latest design of which is hereafter shown in full detail, do not, as in some of the instances which have been referred to, involve in any particular a departure from those general principles of construction which have in long continued practice been found to be correct ones, but are, on the contrary, fully in accord with them, and the successful result of their application here is due to the manner in which their utilization has been carried to a much higher degree than was before considered attainable, or was, indeed, possible under prior constructions, as well as to their combination in such relation that each measurably contributes to the efficiency of the others. The Wootten boiler is strictly within the classification of "locomotive boilers," technically so-called, by which term is meant boilers (whether designed for stationary, locomotive, or marine service) having a horizontal cylindrical shell or waist, connected at one end to a casing surrounding an internal fire-box, and a series of fire-tubes passing from end to end of the shell and serving to conduct the products of combustion from the fire-box to a smoke-box at the further end of the shell. The distinctive features of the Wootten boiler are a comparatively shallow fire-box which is extended laterally to any limit desired, within the width permitted by that of the roadway, and which is located either somewhat above or only to a slight degree below the lower line of the waist; a combustion chamber interposed between the fire-box and the flue sheet, and a fire-bridge extending across the fire-box end of the combustion chamber for a portion of its height sufficient to permit a fire of proper thickness to be carried on the grate without allowing fuel to enter the combustion chamber or tubes, the fire-bridge obviating the necessity, which would otherwise exist, of placing the bottom of the waist at a materially higher level than the surface of

the grate. The crown-sheet is stayed directly to the shell by bolts, in the manner of the side-sheets, crown-bars not being employed.

In these boilers, specially designed for burning bituminous coal or other fuels which readily permit of the separation of small and light particles under a forced blast, a portion of the length of the grate-bars next the fire-bridge is covered over by a fire-brick table, which serves as a receptacle for particles of fuel which may be lifted from the open portion of the grate, and also serves to increase to a considerable extent the volume of the space available as a combustion chamber. A grate composed of alternate water tubes and bars is also a usual accessory, although not an essential element of this boiler.

It will, therefore, be seen that each of the several features specified as essential components of the Wootten boiler has, in modified form, been applied in constructions which preceded it, and that their several results in practice have indicated their correctness in principle, especially so as to the necessity of an increase of grate area, which was recognized early in the history of coal burning, and is to-day undisputed, but the structural conditions of the standard boiler impose such limitations upon its extension as prevent its advantages from being made fully available in that type. Lateral extension of an ordinary fire-box to any material degree, it is well understood, can only be attained by making it overhang the rear driving-wheels, a construction which is absolutely impracticable in high speed engines, consistently with adhesion sufficient for an effective degree of tractive force, whilst it is undesirable, to an extent approximating impracticability, in other classes of engines. The degree of lateral extension obtainable by placing the fire-box above the frames is too inconsiderable to be of moment, and there remains no other direction of increase of dimensions of the ordinary fire-box except longitudinally, the limit of which, with its attendant disadvantage of difficulty in effective firing appears, by the recent instances referred to, to have been reached in affording a maximum grate area of 38 square feet, with a grate 10 feet 9 inches in length. The decided advantage of the Wootten boiler in this particular will be seen from the fact that in fire-boxes of that construction a grate area of 76 square feet is attained with grate bars 9 feet 6 inches long.

The advantages of a sufficient and properly arranged combustion chamber for the thorough and economical utilization of fuel have not met with the same recognition among locomotive builders that they have almost universally been accorded by the constructors of boilers of other types, as evinced in stationary and marine practice, and this fact is due, in the belief of the writer, not to any lack of merit or inherent faultiness of the device, but to the conditions under which their application has, previously to the introduction of the Wootten boiler, been made in locomotive boilers. A species of combustion chamber, although not such in the sense of the term as ordinarily used, was constructed by James Milholland in 1852, and is shown in his Patent, No. 8742, dated February 17th, of that year. This chamber was located slightly back of the middle of the waist of the boiler, and was connected with the fire-box by a series of tubes of comparatively large diameter, and with the smoke-box by smaller tubes. The construction was not used to any extent by its designer, nor as far as known adopted by others, although it has recently been reproduced in a locomotive boiler which is reported as giving satisfactory results, particularly as to freedom from throwing fire. A combustion chamber extending from the fire-box into the waist of the boiler, being the only form properly so designated, was patented in the United States by J. E. McConnell, June 2, 1857, No. 17436, having been previously introduced by him in England. About that time, and for some years afterwards, it was applied here to a limited extent, but did not meet with general adoption, and it is probable that its use has been wholly abandoned in boilers of the standard type. The chief, if not the only, reason of its disuse may be readily found in the fact that as applied with ordinary fire-boxes, having a small area of grate and working under a strong exhaust blast, and having no means for preventing the access of coal lifted from the grate by the force of the exhaust, these combustion chambers filled up so rapidly that the lower rows of tubes were soon choked up and became useless. As an observed instance, a 40-inch chamber, in a locomotive boiler burning bituminous coal, filled up, in a passenger train run of 20 miles, so far that about one-third the tubes were closed by the fine particles of coal.

The application of the combustion chamber in the Wootten boiler, in connection with a grate so far enlarged as to enable a light exhaust to be used, and with a fire-bridge which acts as a barrier to the entrance of solid matter, enables the function of this device in effecting a thorough combustion of the gases before entering the tubes to be fully exerted without the material objection referred to, and from the location and material (fire-brick) of the fire-bridge, it soon becomes intensely heated, and by imparting its heat to the gases passing over it, adds a further useful effect to its primary function of reducing the admissible level of the waist relatively to the fire-box.

The substantial advantages of the Wootten boiler, which may be summarized in that of steaming capacity amply equal to all demands of service with an economical fuel consumption, comprehend in detail the capacity of generating steam with freedom, uniformity and promptness with a lighter exhaust and reduction of back pressure; the ability to utilize advantageously fuels of inferior quality which cannot be burned in fire-boxes of the standard type; facility of firing and of being cooled down as required; a high standard of evaporative efficiency; and a material reduction in the loss of hot gases and unconsumed fuel from the stack, and in the production of smoke.

With the ample grate surface provided in this boiler, intensity of exhaust is not only unnecessary but greatly injurious. Time being an essential element for effecting perfect combustion, as well as for the absorption and transmission of the heat evolved from the fuel, the extended area of grate properly provides for both of these operations and avoids the necessity for the sharp exhaust indispensable with an ordinary fire-box. The economic effect attained is due to the use of a comparatively large grate surface combined with a mild exhaust, the latter reducing the loss from back pressure, irregularity of draft, high velocity of escaping gases, the lifting of fuel from the grate and formation of holes in the bed of fuel, and the ejection of unburned fuel from the stack. Time is allowed for the thorough combustion of the fuel and the absorption of the evolved heat, and the air supply is limited to nearly the minimum amount necessary for perfect combustion. A small percentage only of waste heat is

discharged from the stack and a large absorbent surface is presented for the action of radiant and conducted heat. Waste anthracite can be economically burned, for the reason that being in small pieces of nearly equal dimensions, it lies on the grate in such a manner that the air passing through it is greatly sub-divided and thereby brought into close contact with the individual particles. No large interstices are formed in the body of the fuel through which considerable volumes of air could pass without proper contact and thus afford a supply disproportionate to that required for proper combustion.

The results of carefully conducted experiments made by Dr. Chas. M. Cresson with locomotive boilers of the standard type, yielded for steam generation the following percentages of the total heat obtainable from the fuel, viz.: Anthracite coal, 50 per cent.; bituminous coal, 54 per cent.; semi-bituminous coal, 55.2 per cent. With the Wootten boiler the percentages of total obtainable heat were: Anthracite waste, 69.4 per cent.; marketable anthracite, 65.5; bituminous waste, 64.3 per cent; and bituminous lump, 68.3 per cent.

Evaporation tests of six trips of 100 miles each with George's Creek bituminous lump coal, gave a minimum of 8.80 and a maximum of 9.60 pounds of water per pound of coal, and in one trip with bituminous slack 8.34 pounds of water per pound of fuel consumed.

The performance of engines furnished with the Wootten boiler, on the Philadelphia & Reading R. R. in regular duty, may be fairly accepted as a basis in the ascertainment of the economy in fuel attained by its use, their service on that road having been of comparatively long duration and being of substantially uniform character in the several classes. There are at present 245 engines with boilers of this type in use upon the Philadelphia & Reading R. R., some of which have been in service since 1878. 102 of these are consolidation engines; cylinders, 20x24 inches; grate surface, 76 square feet; weight of engine, 103,000 pounds.

In ordinary coal train service, these engines haul 145 loaded four-wheel cars, or their equivalent in eight-wheel cars, averaging 1,350 tons gross of cars and lading, from Palo Alto to Port Richmond, a

distance of 95 miles, at an average speed of ten miles per hour, over level and descending grades, their average consumption of fine anthracite coal being 11,500 pounds for the trip. On the return trip of 95 miles, in which distance an elevation of 625 feet is overcome, the load is 160 empty cars and the consumption of fine anthracite coal 12,000 pounds.

The experience of the Philadelphia & Reading R. R. Co. has demonstrated for the Wootten boiler an economy of more than 15 per cent. in the use of prepared anthracite coal of such quality as can be burned in fire-boxes of the ordinary type, and when burning anthracite waste, which cannot be burned in the latter, an economy of about 75 per cent. is attained, as compared with the performance of the ordinary fire-box, using the more expensive grade of fuel to which, by its structure, it is necessarily limited.

The reduction in the above company's expenditure for fuel effected by the use of this boiler, from 1880, when they were operating 19 engines of this type, to 1884, when 196 were in service, aggregated the sum of $1,222,117.98, and the cost of these engines having been $2,532,581.98. It will be seen that in an average life of about three years they have repaid nearly one-half of the original cost of their construction.

A passenger engine of this type, No. 372, P. & R. R. R., was entered for competition, as to stated claims made for it, at the National Exposition of Railway Appliances, held at Chicago in May and June, 1883, and was tested in both passenger and freight service on the Chicago, Burlington & Quincy R. R., using anthracite waste, egg anthracite, and bituminous slack. No competitor offered among the other engines exhibited, and the engine, having successfully passed the tests to which it was subjected, was awarded a gold medal for its performance.

On a trip from Chicago to Aurora, 37 miles, made June 19, 1883, using bituminous refuse known as Streator's dirt or screenings, this engine hauled a train of 45 empty stock cars and one passenger coach, steaming with such freedom that the fire doors were open much of the time to prevent too frequent blowing off, no black smoke being emitted and but few cinders, although the slack was very fine, many particles being less than one grain in

weight. The actual weight of fuel used was 6,575 pounds, which evaporated 47,643.5 pounds of water, or 7.15 pounds per pound of fuel. It was stated by those having large experience with Western coals, that no engine having an ordinary fire-box could make steam from the refuse used on this trip.

Engine 372 weighs 89,750 pounds, of which 60,780 pounds are on four driving wheels 68 inches in diameter; cylinders 18½x22. The length of the fire-box inside is 8 feet 6 inches, and its inside width 8 feet, giving a grate area of 68 square feet. The combustion chamber is 31 inches long, and there are 345 tubes, 1½ inch diameter, and 9 feet 2 inches long. Heating surface: fire-box, 151 square feet; combustion chamber, 32 square feet: tubes, 1,232 square feet; total, 1,415 square feet.

Experiments with lignite, containing 20 per cent. of water, made with a consolidation engine in coal train service, developed an evaporative efficiency of 3.43 pounds of water per pound of fuel, and a percentage of total heat utilized of 42.1. On one trip of 58 miles, observed by the writer, the engine steamed with perfect freedom throughout the run, and this fuel appeared to involve no difficulty whatever in firing.

The most remarkable and conclusive indication of the wide range of capabilities of the Wootten boiler in the consumption of fuels of a low grade of calorific value is probably that afforded by its more recent performance with the fine refuse, commonly called sparks or cinders, which is taken out of the smoke-boxes of bituminous coal-burning engines. This material, which is in the form of fine particles of coal, generally coked to a greater or less degree, is, by reason of the comparatively limited grate area and strong exhaust used in the ordinary type of locomotive boilers, ejected from their fire-boxes in such profusion that its retention in their smoke-boxes until a stop long enough for its removal can be made is a matter of some difficulty and inconvenience, and its final disposition, as is well known, has hitherto involved not only the loss of a considerable percentage of the fuel supplied to the tender, but also a positive and material item of expense.

A 16x18 six wheel shifting engine is now performing daily service on the Reading & Columbia R. R., using for fuel, cinders

taken from the smoke-boxes of bituminous coal-burning engines. On a recent trip trom Reading to Columbia, a distance of 54 miles, steam was generated freely from this fuel during the entire run and the engine was worked to its maximum power on the ascending grades of the line, one of which rises 103 feet to the mile. The evaporative efficiency was shown to be 4.4 pounds of water per pound of fuel. Similar material is utilized for locomotive fuel on the Williamstown & Delaware River R. R., and Wilmington & Northern R. R. (an evaporative efficiency of 4.6 pounds of water per pound of fuel being attained on the latter road) and the results have been so satisfactory as to promise a wide and readily available field for economy in the use of an abundant and otherwise practically waste product.

The Wootten boiler being the latest construction which has undergone the test of practical service to any material extent, it may properly close the review of the progress of the art, in connection with which it is to be remarked that while the advantages ot an increase of steam pressure have been recognized and availed of in general practice, from 145 to 160 pounds being now an ordinary working pressure in locomotive boilers, this increase has been made practicable only by correspondingly increased strength of material, staying, and rivetting, and no special improvements designed for, or capable of, permitting a higher steam pressure to be carried appear to have been either adopted or proposed.

THE WOOTTEN BOILER AS COMPARED WITH THOSE OF THE USUAL TYPE.

Any comparison of these types of locomotive boilers, as to relative cost of construction, involving a question only of the outlay for material and labor required in each case, is one which may be readily made with substantial accuracy. The cost of maintenance is, however, in both types, largely, if not altogether dependent on varying conditions which have no necessary relation to either, and cannot therefore be more closely approximated than as a deduction from estimates of a general character. The degree of excellence of the material and workmanship employed in the construction of

any locomotive boiler will materially affect the cost of maintaining it, and assuming these to be of equal grade in two selected instances, the description of fuel and water used, the character of service in which the engine is operated, and the competency and attention of those in charge of it, are all varying elements, which are, in each case, difficult of accurate ascertainment, but which are necessary factors in determining the expenditure required for maintaining the boilers under comparison in effective working condition. The instances of the Wootten and ordinary boilers which are here presented may be taken as fairly embodying the leading characteristics and standard practice in each type, with a general indication of the relative cost of construction and maintenance.

Plate 12 illustrates a Wootten boiler of the latest construction, as designed for and applied in consolidation and fast passenger engines, the particulars of which are as follows:

Straight top fire-box and waist; material, steel.

Total length of boiler..................	27 ft. $11\frac{5}{8}$ in.
Extreme width................................	8 ft. $7\frac{3}{4}$ in.
Smaller diameter of waist, outside.....	56 in.
Largest " " " "	$58\frac{3}{8}$ in.
Length of fire-box, outside..	$124\frac{5}{16}$ in.
Width of " "	$103\frac{3}{4}$ in.
Length of waist from front of fire-box to back of smoke-box	173 in.
Length of smoke-box	36 in.
Diameter of smoke-box..................	$59\frac{1}{2}$ in.
Dome..................................	$28\frac{1}{4}$ in. diam. x $28\frac{1}{4}$ in. high.
Length of combustion chamber........	$43\frac{1}{2}$ in.
Height from grate to crown sheet at back end.............	31 in.
Angle of grate, ascending at rear,....	$\frac{3}{4}$ inch in 1 foot.
Length of grate.....	9 ft. 6 in.
Width of grate................	8 ft.
Grate surface......	76 square feet.
Number of tubes..........................	198.
Length of "	10 ft. $7\frac{1}{4}$ in.
Diameter of tubes	2 inches.

Fire-box water spaces....................$3\frac{1}{2}$ inches.
Diameter of smoke-stack........ ....20 inches.
Height of " ....4 ft. 7 inches.
Heating surface, fire-box, and combustion chamber.................148 sq. ft.
Heating surface, tubes...... ....1,093 sq. ft.
Total heating surface.....................1,241 sq. ft.

Thickness of sheets; waist course next to fire-box, $\frac{9}{16}$ in., dome course $\frac{5}{8}$ in., remaining courses, $\frac{5}{8}$ in.; outside fire-box, $\frac{3}{8}$ in.; inside fire-box, $\frac{5}{16}$ in.; flue sheet, $\frac{1}{2}$ in.; dome, $\frac{1}{2}$ in.

Fire-box stayed with $\frac{7}{8}$ in., stay-bolts throughout, spaced 4 in. centre to centre.

Working pressure........ ....160 pounds.

The cost of all labor and material in the construction of a boiler substantially of the description above given, adapted to a 20x24 inch cylinder consolidation engine, at present ruling prices, is $2,644.

The relative cost of maintenance of boilers of consolidation locomotives, performing an average annual service of 30,000 miles for five years, and including repairs of all appliances and attachments, such as grate-bars, ash-pan, smoke-stack and other like accessories, is shown to have been, for boilers of the ordinary type, $48.35 per annum, and for the Wootten boilers $49.88 per annum.

On the Delaware, Lackawanna & Western R. R. the fire-boxes of ten Wootten engines which were in constant use in severe duty on the Mountain Division, were reported at the end of a period of about 5 years, as not having required any repairs or shown any sign of wear or deterioration.

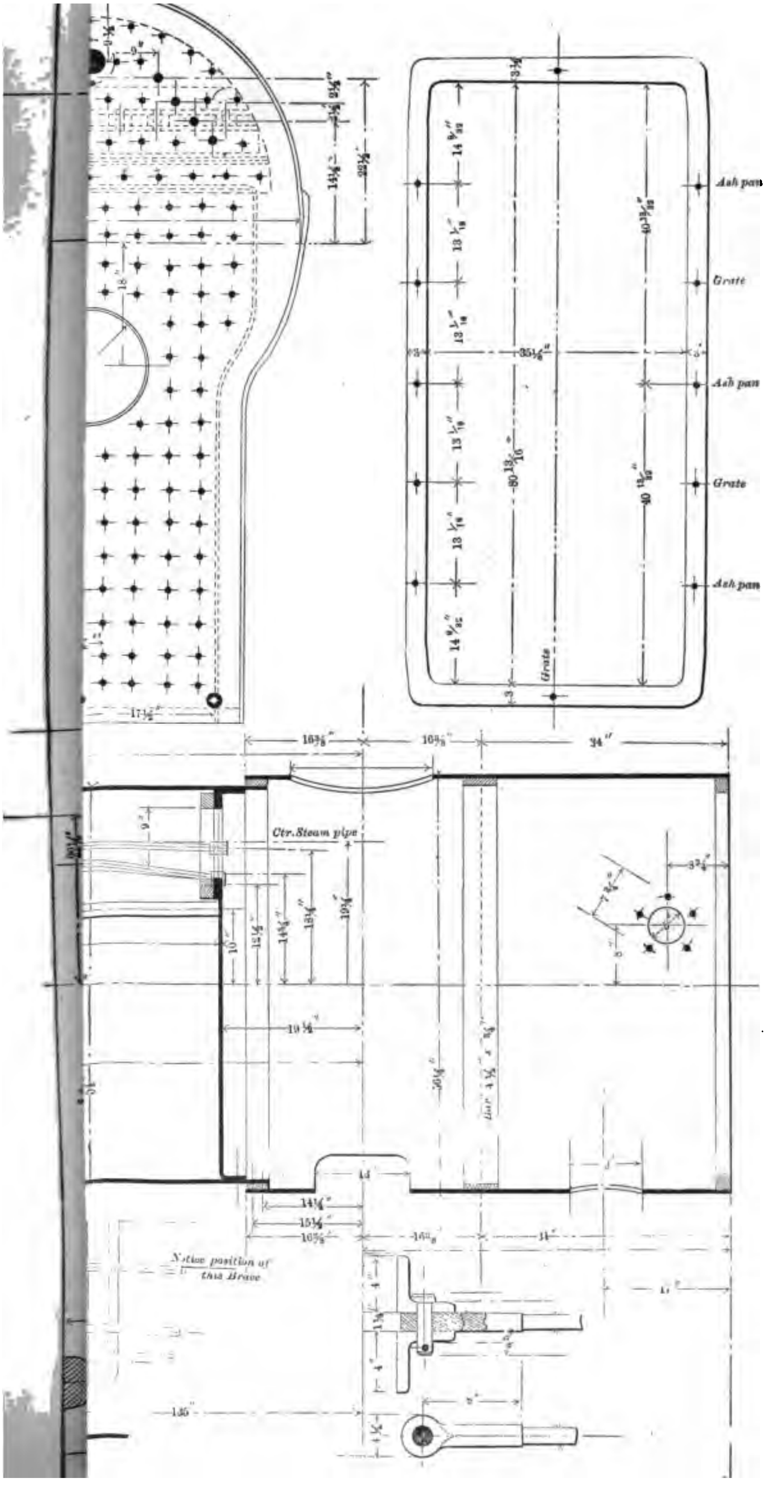
In considering the cost of maintenance of boilers of this type, it is to be borne in mind that a given quantity of heat being necessary for the production of a required volume and pressure of steam, the larger the surface afforded for combustion and radiation of heat, the lower may the furnace temperature be maintained, and it therefore follows, that, by reason of the comparatively low temperature required in the large fire-box of the Wootten boiler, the necessity for repairs and renewals of fire sheets is so infrequent that considerably less expenditure is necessary to maintain them in good condi-

tion than would be required for ordinary fire-boxes in engines doing corresponding duty.

Plate No. 13 represents a locomotive boiler of the ordinary type, as constructed by one of the leading locomotive building establishments for 18x24 inch fast passenger engines using bituminous coal, and exemplifies, both in general design and in detail, the most recent and approved practice in its class.

Pattern, wagon-top; material, steel throughout, except smoke-box, which is of iron.

Total length of boiler, ... 23 ft. 11$\frac{11}{16}$ in.
Extreme width,...... ....56⅞ in.
Smallest diameter of waist, outside,......54 in.
Wagon-top, height,.............................6 in.
Length of fire-box, outside,....... ....88$\frac{5}{16}$ in.
Width of fire-box, outside, ...42⅛ in.
Length of waist from front of fire-box to
    back of smoke-box,....................132⅝ in.
Length of smoke-box,........ ....34¾ in.
Diameter of smoke-box,.......................56¼ in.
Length of smoke-box extension........... .34 inches.
Dome, ...27 in. diam. x 24 in. high.
Length of fire-box, inside,...................80 in.
Width of " " ....34½ in.
Height of fire-box, inside, at front,.........75¼ in.
" " " " " back,.........71⅞ in.
Number of tubes, ...200.
Diameter of tubes,..... ....2 in.
Length of tubes,..................................11 ft., 2 in.
Fire-box water spaces, sides and back,....3 in.
" " space, front,............4 in. at top, 3½ in. at bottom.
Diameter of smoke-stack.....................18 in.
Heating surface of fire-box,..................166 sq. ft.
" " " tubes,......... ....1,172 sq. ft.
Total heating surface,............... .... .1,338 sq. ft.
Grate area,..................................19.16 sq. ft.
Thickness of sheets; waist, $\frac{7}{16}$; throat, sides, back and top of furnace, ½ in.; crown-sheet, ⅜ in.; tube-sheet, ½ in.


Ash pan
Grate
Ash pan
Grate
Ash pan
Grate
Ctr. Steam pipe
Notice position of this Brace

the heads of drums were ½″ thick, braced with screw-stays 1″ diameter. 12 threads to 1″ each stay, supporting about 12 square inches surface. We tested drum No. 2 straight double-riveted seam first; temperature of test water 180 degrees. At 380 lbs. the longitudinal seam leaked bad, at 460 lbs. the seam was bulged out at the center fully 1″; at this pressure the seam ruptured, as shown by black line on Plate 16, No. 2; we then tested drum No. 1, curved seam. Temperature of test water 180 degrees. At 380 lbs. the curved seam was tight, at 500 lbs. the rivets on heads leaked considerably; at 610 lbs. the drum ruptured at point shown by black line on Plate 16, No. 1; this test has shown a difference in favor of the curved seam of about 32 per cent. I was at first surprised at the result, and could not give a satisfactory explanation; I had made close calculations of the tensile strength of the material of each joint after the holes were drilled, and the calculation was slightly in favor of the double-riveted seam. I am convinced that the increased strength developed was owing to the addition of more material at the weakest point of each section a boiler may be composed of. I have had considerable experience constructing and repairing boilers for western river service. Where steam pressure of from 170 to 200 lbs. is required of material that must not exceed $\frac{26}{100}$ of an inch in thickness, the most trouble with these boilers is in making and keeping the longitudinal seams tight, under the excessive pressure; in nearly all cases the side seams would spring, and bulge out, loosening the caulking, and frequently receive a permanent set. Often, after cutting out the rivets, would discover cracks that would require renewal of sheets. These defects in every case would show more prominent at the center of each section, and the wider the section, the more troublesome this defect would prove. This defect does not appear so prominent on locomotive boilers for railway service, as the material is of greater thickness; still the same defect exists, and the same law governs in each case. In your long experience in the locomotive department, you have seen many instances of sheets cracking at the caulking edge and between the rivet-holes of longitudinal seams; this is owing principally to the weakness indicated above, and the strain being in a straight or direct line. The question arises, how to avoid these defects, and

construct the steam boiler so that all points will approximate nearly uniform strength. My view of the problem is that in order to strengthen, more material must be introduced at the weak points, and it is of the utmost importance that the line of strain must not be in a straight line; if the line of strain is broken, and distributed over a larger surface of the plate, it will prevent the strain from centering at one point on line. My aim has been to design a longitudinal seam that would be as strong at the center of sections as at the point of circumferential seams, and at the same time not add materially to the cost of the boiler.

I enclose sketch of what we call the Diamond Lap; this form has not been tested. In reference to cutting the ends of plates on a curved line, will say that we have had correspondence with plate manufacturers, and they inform us that owing to the reduced waste trimming the plates, no extra charge would be made. Please find sketch of plate as it comes from Mill Rolls.

In conclusion, will say that our apology for sending this long letter, is that the subject of boiler construction is of such importance, and the field of operations has been so lightly explored, that we feel that any suggestions that may be offered will be of future benefit. Yours truly,

JOHN E. JERROLD.

THE PRESIDENT—The report is now open for discussion, but as members do not seem anxious to discuss it, and as there should have been several committees appointed by the Chair yesterday, I will appoint them now. I will appoint as the Assessment Committee, R. H. Briggs, J. T. Gordon, and William Fuller; I will appoint as the Audit Committee, G. W. Stevens, H. Tandy, N. W. Howison; I will appoint on the Committee on next place on Meeting, M. L. Collier, H. A. Whitney, and C. Blackwell.

J. N. LAUDER—I desire to make a motion that I think might perhaps be properly acted upon at this time, and that is, that when this Convention adjourns to-day it be to meet again on Friday morning at 9 o'clock. I make this motion because to-morrow is a legal holiday in Massachusetts, being the 17th of June, and I think it is proper that we adjourn over until the next day.

JOHN BLACK--I second the motion.

H. N. SPRAGUE—Wouldn't it be well to decide first whether we shall have to hold an extra session?

J. N. LAUDER—I think there will be only routine work on Friday, and if we should decide before adjournment to-day that it is necessary to hold an evening session, we can hold it to-night, but I think that this motion should pass now. Perhaps it is not quite the thing to bring up in Convention matters in reference to entertaiment—I think it is bad policy—but it is well known by all present that an excursion has been arranged for to-morrow, with a view of it being a legal holiday.

N. W. HOWISON—I don't see why we can not have a session to-night, because if that motion prevails it will keep a great many of us here who want to go home to-morrow.

THE PRESIDENT—I will put the question on Mr. Lauder's motion.

[The question was then put, and the motion was carried.]

J. N. LAUDER—It seems to me that this report on Boiler Construction ought not to pass without some discussion. The interest in this subject ought to be on the increase instead of decrease, and I hope that members will see fit to discuss this report to some extent. There is one little detail about the construction of locomotive boilers that I would like to mention, and that is the fastening of the inside fire-box to the outside shell at the bottom. I can see no reason why there should be any leakage at the bottom of the furnace, at the corners especially, any more than there should be at the dome. When I see a boiler leaking at the bottom, it seems to me that it is from a fault of construction, which ought to be and can be remedied.

There is no question but what you can make the union of two parts of the boiler at the bottom just as strong, and free from liability to leak, as you can make any other part of the boiler. But we don't do it. Why? Simply because we haven't given the thought and attention to that matter that we ought to have done. Now, I have commenced to do what I believe will obviate that difficulty. It is not needed so much in the East as it is in the West. I now make the mud-ring deeper and with double rivets. I say if one row of rivets won't keep it tight and keep it from leaking, put in two rows. If two won't hold it, put in three, and if it is necessary to put in ten rows of rivets around the bottom of a boiler to make it safe and free from leakage, let us put in ten rows, but let us get rid of the annoyance of the leakage around the bottom of our furnaces. I think a double riveted mud-ring will cure the difficulty. I have adopted that style of construction.

E. A. CAMPBELL—I would like Mr. Lauder to explain how he fixes the rivet in around the corners.

J. N. LAUDER—In precisely the same way that you would with a single

riveted ring. Of course, those rivets, properly speaking, are screws from the outside. I think in my construction these four are tapped and screwed into the mud-ring and then headed up. That is the only way I think it can be done. Those that can be put through are done so. Then on the outside they are tapped and the plug screwed into the ring and headed over in the usual way.

E. A. CAMPBELL—That is one difficulty that I have had on my road —leakage around the corners of the boiler.

SECRETARY SETCHEL—I am sorry that Mr. Stevens, the chairman of the Committee, is about to retire at this time. We generally look to the chairman of the Committee to introduce the subject in a way that will create interest, and I should very much like to hear from him. Mr. Stevens has recently put some very heavy engines on the Lake Shore road, carrying a very heavy pressure of steam, 180 pounds, to which reference was made in his report, and I understand that they are working very successfully, and for that reason I think the members would be very glad to hear from him on the boiler question. 180 pounds of steam is a very high and unusual pressure, and while the general tendency seems to be in that direction, it is a question of how far we can go as to pressure, and what kind of material we will have to use in order to retain it properly.

[At this point Mr. Stevens made his appearance.]

G. W. STEVENS—In answer to the gentleman I want to say that this style of engines has not been long enough in service yet to say definitely as to the benefit of high pressure. To use a slang phrase for it, "the engines get there." I fail to see that in a boiler of proper proportions why there should be any objection to carrying a high pressure of steam when it is needed. Those engines are built to run on fast and extremely heavy trains.

[On motion of H. N. Sprague, the discussion on this report was closed.]

THE PRESIDENT—I believe the next report is that upon "Standard Driving-Wheel Centers and Standard Sections of Tire." It is in the hands of the Secretary and will now be read.

[The report was then read.]

E. A. CAMPBELL—I move that the report be accepted and the Committee discharged.

M. N. FORNEY—Before the vote is taken on that motion I desire to say that it strikes me that it would be unwise to discharge that Committee. It is quite possible that the Association may not accept the form of flange that the Committee recommends. I speak of this for the

reason that in another Association—in which I do a great deal of talking, as I do in this one—the matter of the flange has been up for a number of years, and we found that there was a great difference of opinion. We have made another try at it this year, and we think we shall succeed; and I think before this Association takes any action upon it we had better wait until another year and see what they do.

E. A. CAMPBELL—Then I will simply move that the report be accepted.

[The motion to accept the report was seconded and carried.]

COMMITTEE'S REPORT.

To the American Railway Master Mechanics' Association:

Your Committee appointed at the Eighteenth Annual Convention to consider the subject of "Standard Diameters of Driving-Wheel Centers, and Standard Section of Tires" beg leave to submit the following report.

In considering the question of standard diameters for driving-wheel centers, we have thought best to recommend such diameters as would enable the largest number of locomotives now in use to be brought to the proposed standards with the least trouble and expense.

To enable us to arrive at proper conclusions, we caused circulars to be sent to each member of the Association, requesting information as to the diameters of wheel-centers now in use on their respective roads.

We have received replies from thirty-eight of the leading roads, owning an aggregate of nearly eight thousand locomotives.

While we find a great variety of sizes of wheel-centers, the variation is not so wide as to preclude the possibility of bringing a large percentage of them to a standard.

Your Committee feels that this question is one of great importance as well to the manufacturers of tires as to the railroads; as in the case of the manufacturers, the adoption of standard diameters of wheel-centers by the railroads will enable them to carry a stock of standard tires, which can be made up at their convenience; and in the case of the railroads, the necessity for carrying a stock of tires will be obviated, because manufacturers will be able to fill orders at short notice.

If desirable, manufacturers can furnish tires bored to gauges, ready to be applied to the wheel-centers. This will be a substantial benefit to both parties.

In considering this matter, your committee believes it most practicable to establish the diameters of the wheel-centers, making them even inches, and allowing fractional parts of the inch to apply to the diameter of the tires.

We would recommend for standard diameters of driving-wheel centers for the various sizes of wheels in use under locomotives of standard gauge, 38", 44", 50", 56", 62" and 66".

Your committee considers it unadvisable to take action in this matter with reference to narrow-gauge locomotives, as there are comparatively few roads of gauge other than standard and those now in existence are rapidly changing, so that in a few years the railroads of this continent will be, with very few exceptions, of uniform gauge.

We would further recommend that arrangements be made with The Pratt & Whitney Co., or some other reputable manufacturer, to furnish gauges for both wheel-centers and tires, to railroads, locomotive builders, and tire manufacturers, at a reasonable price to be fixed or agreed to by a representative of this Association; to the end that all parties in interest may have absolutely uniform gauge measurement.

Without such uniformity, it will be impossible for manufacturers to furnish tires bored to fit, with certainty that proper shrinkage is allowed.

We believe the requisite allowance for shrinkage to be one one-hundredth part of an inch for each foot of diameter of wheel-center.

We have also prepared a drawing of section of tire (see Plate 18), which we submit to the Convention for consideration.

J. N. LAUDER,
J. JOHANN,
H. N. SPRAGUE.

M. N. FORNEY—I think it is certainly an important matter that we should adopt the best form of standard tread for locomotive tire. In the Car Builders' Association we have talked about it for several years

past, and this year another plan has been proposed, which is somewhat modified from that of previous years. It strikes me that it would be very unfortunate if the form of tread and flange which should be used for locomotives should differ materially from that used for cars, for the reason that if you have a form of tread rolling over a rail of one shape, naturally, we wear the rail in one position. Then the car wheel would follow along the rail with a tread of a different shape and wear the rail in another position. I, therefore, think that it is desirable to have the form of tread for car wheels the same as engine wheels, and the tread of an engine wheel the same as a car wheel. I think this form of tread should be submitted to the members, and each of them should have an opportunity of judging what it is. I think it would be quite impossible to get an idea of its merits from simply hearing this report read. The one point in particular in which I feel disposed to criticise the form proposed is in the radius of the throat which joins the tread to the flange. That is made only three-eighths of an inch. The radius of the throat which is proposed for car wheels is now five-eighths of an inch. I hope the members will all discuss this very fully and let us have the views of all here present.

J. N. LAUDER—I suppose, as Chairman of the Committee, I must defend that report. In reply to the main criticism of Mr. Forney, that it has always been thought desirable by most of the speakers in discussions about this subject to have the radius of the throat considerably smaller than five-eighths of an inch, yet the difficulty is that it would be impossible to get a chilled wheel with a much smaller radius and get a good chill in the casting. It seems to be the sense of mechanics that the radius of that corner should be smaller than five-eighths of an inch, but here was the mechanical difficulty which was that it was difficult to get a good chill in the corner with a wheel smaller than five-eighths of an inch. Now, we are discussing the locomotive driving-wheel tire. We can get any radius in the corner that we please. We have submitted this for criticism and adoption, if thought best; but I am not at all sure that we ought to adopt any form of wheel tread at the present time. I think, as Mr. Forney does, that there should be some uniformity between this Association and the Master Car Builders' Association on the question of the tread of tire and wheel. Now, there is another thing. No matter what we put in for a section of locomotive driving-wheel tire, it remains that section only a very short time. So that the difficulty that Mr. Forney speaks of, of the engine and cars having different forms of tire would only last a short time any way. I will admit that that does not justify us in adopting a section of tire that is wrong, bu I am aware that there are a great many different opinions, and as much

and have each piece absolutely like the other. Their machines and measurements would vary in some respect. Now, I hope that these sizes will be adopted. If there is anything about them that seems to be wrong let us hear what it is. There is one size which has been suggested by several that I left out, and that is sixty inches. We recommend fifty-six and sixty-two. I find that there are quite a number of roads that have a wheel center of sixty inches. I have five engines with wheel centers of that size, and I think it is a very desirable size of wheel for mixed service. It is large enough for quick passenger service, and not so large but it does very good service on freight, and is a size that is very handy, and, if it is thought desirable, that size might be added to the others as one of the standards.

JACOB JOHANN—I fully agree with Mr. Lauder, that the first question for the Association to settle is the standard diameters for wheel centers, which, as a matter of course, will give us the internal diameter of the tire. I apprehend that by the external shape of the tire there may be quite a difference of opinion among members, and there is no reason why each member cannot have his own peculiar shape on the outside that he wants. The main point is the establishment of standard wheel centers which, of course, will bring about the standard tire. That is a question that is important to railroad companies, and it is a matter of economy, and it is a matter that can be accomplished without unnecessary expense. I have on two occasions, in fact, now I am on my third term, of uniforming wheel centers. My first experience in the matter was in the engine days of wrought iron tire. I had charge of about sixty-five engines of different kinds in the early days of railroading, before they were very close in giving specifications. They would specify five-foot wheel, or five-and-a-half-foot wheel, but there wouldn't be anything said about the diameter of the wheel centers. At that time, in the western country, it was necessary more than now to carry large stocks, because the transportation was not so expeditious as it is now. Hence, I took the matter into consideration and got the diameters of all the wheels to see what could be done. Well, of the sixty-five engines we brought them all, with the exception of six, within the specified units of the standards, and those six we simply maintained them as we did previously as special. The others were all uniform to standard, and as fast as they received new tires the new ones were turned to the new standard, and when that was done we kept, practically, two or three set of tire on hand, and could tire any engine that we had. Subsequently steel tire came into use. I was connected at that time with the Wabash road. We had a great many engines of the older types and sizes. I took the matter in hand, and when I left there, a year ago, they had five

hundred and eighty-four standard gauge engines, and their centers were all brought to uniform standard, 44, 50, 56, and 62. There were a few left that wouldn't come to that, and, of course, they were left. Now, the important point is to establish uniform centers. Then every master-mechanic will bring all the centers that he can to that standard, and those that he cannot he will still continue as he has until they are worn out; and the locomotive builders, I hope, will have interest enough in this matter so that if these standards are adopted, unless they have specifications, they will build their driving-wheel centers to these standards, and in that way you will ultimately establish the standard wheel center. In that way it can be done without unnecessary expense, and then it will be a great deal more convenient for you all, than by the present way, where you have a variety of sizes for the diameter of the wheel, and the tire-maker does not know what stock to keep on hand, and by adopting a standard size for different diameters, and the sizes that have been recommended by the committee, we deem are very proper sizes, and all sufficient for the various classes of engines that are now built. I hope the members will come to some determination on uniform sizes.

M. N. FORNEY—In order to get this subject up I would move that the form of tread of flange be postponed for the present. My reason is that at the Car Builders' meeting a form of tread was proposed, and, according to the constitution of that association, it must be submitted to letter ballot. It will, therefore, go to letter ballot, and I think this Association should await their action before they adopt a form of tread.

[The motion was seconded and carried.]

N. E. CHAPMAN—Some years ago a Committee was appointed by this Association to take up this same question. They reported to the Association, and I hope if this report is adopted it will not meet with the fate that the other did, as I think there was very little notice taken of it by the master mechanics of the country, or by any of the railroads. It is an important question I think, not only to the railroads, but to the manufacturers. I have had about twenty years' experience on railroads and about three years in the manufacturing. While the size of the wheel center is the most important to the railroad, the shape of the tread and flange is of the most importance to the manufacturer. We have now, from a great many railroads, heard that very few of those are uniform. If we adhere strictly to the blue prints it is necessary that we should have a set of rolls which cost from $300 to $400 in order to conform strictly to those blue prints. It seems to me that it is important that the size of the wheel centers should not only be adhered to but that the tread and flange should be as uniform as possible. That would enable the manufacturer to carry a stock on hand, and you, in ordering tire,

could very promptly have your orders filled. I do not think there are many of the manufacturers at present that are in condition to bore the tire, but if they found that it was to be required of them they would very soon arrange for it. We are running seventeen bore mills, and have five more on the way to be put in. We would be very glad to do it. It is no source of profit to the manufacturer to bore the tire. It is done as near cost as possible, but it would make it a uniform thing, so that it would enable the manufacturer to carry the tire in stock and fill orders promptly.

H. N. SPRAGUE—Are any of the manufacturers rolling that bevel on the tire on the outer edge?

N. E. CHAPMAN—Yes, sir; nearly all of the orders that are received at this time have that. Some few are carried out on the taper to the edge, but a great many are rolled with that taper on the outer edge of the tire.

THE PRESIDENT—I am pleased to announce to the Convention that we have present Mr. Verbryck, the President of the Master Car Builders' Association. [Applause.]

[On motion, Mr. Verbryck was invited to a seat on the platform.]

N. E. CHAPMAN—I think the suggestion make by Mr. Lauder and Mr. Johann to have a set of standard gauges made by some tool manufacturer is an excellent idea, and I think it would be necessary that each road should have a set of the same standard gauges. The custom of ordering tire bored is largely on the increase from some of the most prominent roads in the country. In regard to the adoption of the standard wheel center, a short time ago an order was sent in for four tires for one locomotive, and there were not two of the tires of the same size.

N. W. HOWISON—This is what I call legislation for a future generation. This is one of the most important subjects I think that this Association can deal with, and the adoption of the standard, as recommended by this Committee, ought to have the undivided attention of the Association and every member connected with it, and by the adoption of these standards, in the course of time all roads will strictly conform to the standard sizes adopted and recommended by this Committee. But if the members, when we go away from here, lose sight of that fact, it is no use for this Committee or any other Committee to make a report. I find that when we leave here and go home these recommendations are not strictly adhered to, and my friend, Mr. Chapman, says that at our former Convention there were Committees appointed on this very subject, and still you have to have another Committee. The recommendations of the last Committee have not been adhered to. Now, then, it becomes our duty to look seriously into this matter,

The standards as adopted will take but a little time to bring out uniformity. As I said before, it is legislating for a future generation which the country will reap the benefit from.

J. N. LAUDER—I would inquire of Mr. Chapman if he can give us any information in regard to what advance there probably would be in the price of tires, if any, provided they were bored to gauge?

N. E. CHAPMAN—Half a cent a pound.

J. N. LAUDER—That occurred to me in the preparation of the report. My idea is that competition will regulate that price. I see no reason why it shouldn't as well as it regulates the price of rolling tire.

JOHN MCKENSIE—I would move that that part of the resolution which refers to the wheel center be adopted as the standard by this Association.

H. N. SPRAGUE—I would add to that motion, that as between 56 and 62 we add a 60-inch center.

HENRY SCHLACKS—I second that motion.

JOHN MCKENSIE—Now, if we are going to do that, I would add a 42-inch center. But I hope that amendment of Mr. Sprague's will not prevail.

N. E. CHAPMAN—I would state that I have heard of many instances, and know of quite a number, where a master mechanic has desired to enlarge the size of his wheel center and has done that in the putting on of new tire by, instead of taking off the old tire, turning it down to the size desired and shrinking his new tire on that, making it a band for enlarging the size of his wheel center, and I have not known of an instance yet where there has been any trouble from it. Mr. Cooper, of the Lake Erie & Western road, has done that, and he might state whether he has had any trouble from it.

H. L. COOPER—I have some eight engines that I have increased the size of the wheel centers by leaving the old tire on and turning the flanges off and setting the new tire over them. I have run them four years and had no trouble with them. The tire we use in all cases is four inches.

J. N. LAUDER—In reference to that I would say that the information we got, in reply to our circular, was that it would be necessary in many cases to do that very thing in order to bring about this uniformity that we speak of. There are quite a number of roads that have centers of forty-nine inches, and by so doing they can gradually work them up to fifty inches. All roads will probably have some special sizes that these standards do not cover, and there is no particular objection to it, but it is chopping it up pretty fine to get a size between those given.

JACOB JOHANN—I hope the members will take this matter into serious consideration, and that each member will not get up here and have his own particular size added onto the list. The object in establishing standard sizes is to reduce the number of the different sizes that are now in existence. Out of sixty-three engines that I have now, there are not ten of them that will come to these standard sizes, but I am ready and willing to sacrifice them for the standard sizes, and I will find a way to get over the variation, until I can get rid of them entirely. The object in establishing a standard wheel center is to have but one center of each specific diameter of wheel; that is, what you may term a four-foot wheel, a four-and-a-half-foot wheel, or a five-foot wheel. There is no question but what these sizes that the Committee have recommended comprise the largest proportion in use to-day on railroads. Now, about that sixty-inch wheel. I have quite a number of them. These gentlemen can carry them along and can still get tire for them just as they do now. What we want to establish standards for, is for the locomotive builder to build his driving-wheel centers to a uniform standard, and for the tire manufacturer to know what size to roll his tire, that he may keep them in stock. While I will, of course, acquiesce in the decision of this Convention, I shall be very reluctant to add any more sizes to those now recommended. We think that the largest proportion of the wheels that are in use to-day on railroads will come to these sizes, and those that are to be built in the future will be built to them, and hence in a very few years we will have them all standard, and these special sizes will wear themselves out and get out of the way.

H. N. SPRAGUE—I assumed that the sixty-inch center was not a center that the Committee agreed to get rid of.

THE PRESIDENT—Was your motion seconded, Mr. McKensie?

J. MCKENSIE—Yes, sir.

A MEMBER—I seconded it.

[A vote was then taken on the amendment proposed by Mr. Sprague, and it was lost.]

[The question then being on the motion to adopt the suggestions of the Committee was carried.]

THE PRESIDENT—The question on form of tire is now open for discussion.

J. MCKENSIE—I move that the discussion of this subject be postponed for one year, and the Committee continued for another year.

[The motion was seconded and carried.]

ANGUS SINCLAIR—Mr. Wall, master mechanic of the Brooklyn Ele-

vated Railroad, who is very modest, and who does like to hear himself speaking before your honorable body, has just requested me to draw your attention to the fact that you have ignored the kind of machinery needed for the elevated railroads, and it is a growing kind of machinery that seems to deserve some attention from the Committee. The sizes that you have settled upon, with one exception, are all too large, and they cannot be ground down to that one size, and he thinks that you ought to take it up and reconsider that part of the subject, as there are likely to be constructed a great many more suburban and elevated railroads with small engines and small wheels.

JACOB JOHANN—Before laying away the wheel center subject, I would suggest that the Committee would like to have some instruction in reference to the gauge question.

THE PRESIDENT—It is not closed yet.

JACOB JOHANN—The Committee would like to have the sense of the Convention as to what they shall do with the tire-gauge question.

H. D. GORDON—I move that this Committee be instructed to make arrangements with some firm to procure these gauges.

J. S. MCCRUM—I second the motion.

SECRETARY SETCHEL—I would suggest as an amendment that the Committee see if such an arrangement can be made.

J. N. LAUDER—I think the motion is just right as it is. The Committee will authorize them whenever they get an order for gauges to make that gauge and make it for certain sizes and at a certain price.

[The motion of Mr. Gordon was put to vote, and carried.]

JOHN MCKENSIE—Wouldn't it be well to put upon that Committee some gentleman connected with the elevated railroad?

E. A. CAMPBELL—I think that would be a good idea to have some man connected with elevated railroads upon that Committee.

JACOB JOHANN—I have just suggested to the gentleman connected with the Brooklyn Elevated Railroad, that he can adopt his own sizes of tire, and then when he comes here next year we will be very glad to add that to our report.

J. N. LAUDER—We took this matter of roads other than the standard gauges and there being so few of them we thought it was not best to make any standard for them. There is probably but one narrow gauge road to-day, the Denver & Rio Grande, that will maintain its gauge for any length of time, and the other roads, as Mr. Johann says, will be a law unto themselves. However, if the parties in interest on the elevated roads wish this Committee to take that matter up and make recommendations to the Association the coming year, we will be very glad, I have no

doubt, to hear from them. The Committee is continued. I suppose, Mr. President, that the question of discussion on tire section is not properly now before this Convention. It has been postponed practically for a year. I am very glad that action has been taken, because I would like to have the Committee confer with the master car builders and see what they have done, and possibly we can make the section of tire uniform in both instances.

[On motion of John Black, the discussion on this subject was closed.]

[At this point the Committee on Assessment reported, recommending that the assessment for the coming year be five dollars per member, which report was adopted.]

[On motion, the Convention took a recess of ten minutes.]

[AFTER RECESS.]

THE PRESIDENT—The hour has arrived for five minute discussions on questions suggested by members.

THE SECRETARY—There are no questions on the Secretary's table.

THE PRESIDENT—Has any member a question to propose?

W. WOODCOCK—I have one: "Is it desirable to continue the use of steel for driving-axles?" I was led to suggest this question because of the fact that a member stated that he had used steel but had gone back to iron.

J. N. LAUDER—I have some decided views about this. My experience since homogeneous steel first came into use for axles and the like, has been of such a character that it has given me very decided views against it, and those views are that steel, no matter of what make it is, is an unsuitable material for such purposes. I hold that opinion to the extent that I have taken engines less than three years old and taken out the steel pistons and axles, and substituted iron when everything was apparently all right. I didn't dare to run them for fear of breaking. My observation and experience has been of that character that I did that simply to make everything safe. Perhaps others may have had a different experience from what I have had, but I have had very poor results from steel. I would say, however, that I had not been in the habit of using Krupp steel. It has been mainly open earth steel. I believe that perhaps in some instances where steel has given me bad results, it was owing to the form of designs because it is probably well-known among members that sharp corners in steel is inviting disaster. We have broken on our road quite a number of steel axles in the past year or two, and in every instance they were cracked, in some cases entirely around the axle, having nothing but a spot in the center to hold

them. That I have seen also in iron where the wheel fit was turned down considerably from the sides of the journal, and left a square corner. With good homogeneous steel and sharp corners avoided, I presume steel would give good results, but my experience has been in the other direction. As far as the wearing of the material goes, I preter iron. It runs much longer than steel. Whether it is due to the fact that iron gets better lubrication or not, I am not prepared to say. Possibly because of steel being a denser material it does not get as good lubrication as iron. That may account in some measure for the difficulty of running steel without heating. Steel will break in curious ways. I look upon it as uncertain material. Where the part is subjected to strains, particularly, like a piston rod. I have had piston rods break in the cross-head half way between the end of the key way and the shoulder. It ought to have broken at the shoulder or through the key way. Those were the weakest parts. Instead of that it took the erratic course of breaking, just about half way between the two weak points, and that was as clear metal as I ever saw.

W. WOODCOCK—My object in suggesting this question was more in regard to the driving-wheel. My experience is just the reverse of Mr. Lauder's. My experience with iron is that in an axle the edges adhere and scrape the brass, and in the oil-box we find quantities of brass just cut right out. Now, with the steel axle we don't experience that trouble because we get a homogeneous material. In that respect I think we have an advantage in the use of steel over iron. If you could get a first-class quality of iron we get very good results, but that is one of the difficulties with which we have to contend. In steel we are sure of getting a homogeneous metal.

J. S. MCCRUM—My experience with steel and iron axles has been similar to Mr. Woodcock's. Some years ago I used iron axles altogether and I found difficulty in getting good forging. Then I commenced to use steel driving axles, and I have had no trouble with their breaking. I don't think that the steel surface affords as good a wearing surface as the iron, but yet we run them quite successfully, and never have had any of them broken. I have about fifty locomotives with steel axles that have run four and five years. On the whole if I could get a perfectly good solid iron I believe I would like it as well as steel, if not better, but my experience with steel has not been unfavorable.

J. N. LAUDER—I think the breakages of steel is largely due to faulty design. I think the turning of the wheel down below the diameter of the journal, or, in fact, having anything where there can be a sharp corner of any kind, invites disaster in steel more than it would in iron. So that I presume my experience perhaps in the use of steel for axles has

been brought about largely by fault in the design of the axles rather than in the material. Possibly it may be that, but I still think that a good quality of iron is the safest metal that we have ever yet had for axles.

J. S. McCrum—There is very little difficulty if there is only one-eighth inch between the diameter of the wheel-pit and the journal of our driving-axle, and we avoid making a sharp corner.

J. N. Lauder—Wouldn't it be better to put in straight without any shoulder at all?

J. S. McCrum—I believe it would. I say I agree with Mr. Lauder, that I think it would be better to have the journal and the wheel-fit of the same diameter, and the axles parallel. It is only for a matter of convenience of putting on the wheel if made that way.

Angus Sinclair—In going around visiting with the master mechanics I was very much struck with the diverse opinions that existed in relation to the use of steel for axles and pins. Go to one place, and the Master Mechanic would not have anything to do with steel at all; iron was the best in every way; he was satisfied that iron was the best. Go to another Master Mechanic, perhaps in the same city, with engines running very much under similar conditions, and you would find that he was just as much in favor of steel as the other man was in favor of iron. Now, in trying to investigate the subject somewhat, I come to the conclusion that Mr. Lauder has come to, that the leading objection to steel was bad forms. I think that steel is decidedly the more reliable axle, if the form is properly made; but, on the other hand, I think, with a bad form, it is not so reliable as iron. There is no road in the country that keeps a better statistical record of its engine mileage than the elevated railroads of New York; and I think their experience with steel has been more definite, and is worthy of our attention. It is necessary for them to keep down their weight as much as possible, and consequently, every part of their locomotive is just as light as it can safely be made. They tried iron axles first, and the breakages required them to take to steel. It is very undesirable, as you men all understand, for an axle to break on any road; but especially on an elevated railroad. They tried steel and iron, and they kept a very close record of their comparative merits. The conclusions arrived at were that you sometimes get an iron axle that will run very much longer than a steel axle; but at the same time, it might break with a fifth of the wear that you can depend upon getting out of a steel axle. If an iron axle would run, say more than fifty thousand miles, you could depend upon a steel axle running three hundred thousand miles. A steel axle, again, would

very rarely break under a given mileage; and they got down to it so exactly that they could tell within ten thousand miles or so of when a steel axle would fail. I think Mr. Wall, if he would give us some of his experience, can supplement what I am saying. They have now decided that a steel axle has a known life, and the iron axle has not. An iron axle may be made better than a steel one, but you cannot tell when it will break. Those who have watched iron axles that have run a very long mileage, say that have been twenty years in use, will in many cases have seen that the tendency of iron is to form into distinct strands, and your axles will be all a series of cracks. I think that is a very objectionable feature for an axle to have, for you can never get the journal to run without additional friction; aud if that objection holds good against the regular wearing of an axle, there seems to be nothing in its durability to recommend it for use.

MR. WALL—I think Mr. Sinclair is right. The breaking of steel we have found is largely due to bad forms. We have inserted all our crank pins without any shoulder. We have frequently had pins break; where they are filleted, we have no breakages. The same way with our driving-wheels. As regards locomotive axles, the New York people have reduced that down to a science. They run a steel axle so many thousand miles, and then take it out; they do not break at all; but with the iron axle, there is no real age to it. They have broken sometimes after running only a very short time.

SECRETARY SETCHEL—There has been a question that has interested me somewhat, and I should like to hear the views of members in regard to it. As to the proper manner of fitting truck brasses or liners, as they are sometimes called, in the truck-box casting.

I have recently fitted up some engines very closely, (and I have often done the same thing before) planing the brasses and boxes and making everything very accurate, and seeing that the truck would tram just as exact as the drivers themselves; and some of my friends think that is too tight, that truck-boxes or brasses ought not to be fitted up in that way, that is, that there ought to be room for them to come and go, as they express it.

If the box accidentally gets hot, when it is fitted so tight, it will hug the axle, and they claim that there should be room for it to rock a little. Then, the question would arise: Are the wheels not liable, from the tipping of the brasses either one way or the other, to throw the truck out of tram enough so that the wheel would cut the flange on one side. I see that there is force in the argument that when brasses are fitted perfectly tight, if by any means the brass gets to heating, it is very liable

to hug the journal too close, if there is not ample room allowed on the sides so that it will clamp on the journal. I have recently visited a road where they make no pretensions of planing the boxes or brasses, and they told me that they never have any hot boxes on the trucks. I recently had occasion to examine engines where the foreman told me they made a practice to put in their wheels without facing the hub, and without planing the brasses, and I think the appearance of their engines fully justifies the claim.

J. McKENNA—Did you also ask the foreman how much lateral motion he allowed?

SECRETARY SETCHEL—No, sir; I saw that for myself; it was not less than half an inch in any of them.

J. McKENNA—If the engine was in good gauge the center of the engine would certainly carry it straight, while the wheels would be allowed to vibrate laterally; but I don't see how there could be any wear on the hub. I presume it is the practice of all the members here that, when they get a half inch pull on the hub, they want to take them out in order to keep the engine running straight, and prevent the flange wear on our drivers. There may be some economy in putting engines up in that manner, but I fail to see it. My practice has been that the closer you get to a perfect truck the better results you get. It is just as necessary, in my opinion, to fit up a truck accurately as it is to fit up a driver accurately.

[On motion of Angus Sinclair, seconded by John Black, the discussion of five minute subjects was closed, and the regular business was proceeded with.]

THE PRESIDENT—I have a communication here, signed by William Woodcock, Jacob Johann, and John Campbell, respectfully presenting to this Association Mr. Thomas Shaw, mechanical engineer, for associate membership.

Our usual practice in these matters is to hand over the proposal to a special committee. And if there is no objection, I will hand this communication to a Committee consisting of Ex-President Lauder, G. W. Stevens, and James Meehan. I believe Mr. Stewart has a personal communication to make to this Association, and if there is no objection, I would ask Mr. Stewart to make it at this time.

MR. STEWART—It has been announced here that there will be an excursion down the harbor to-morrow, and, as may be known to members, the Fitchburgh road runs through the great Hoosac Tunnel, and I have thought that perhaps that there might be some of our master mechanics who would rather avail themselves of an excursion up through the Tunnel

than to go down the harbor; and I would, therefore, extend the courtesy of the Fitchburgh Railroad to any of our master mechanics who may wish to make that trip. They can leave Boston to-morrow morning at half past eight and return the same day; or, they can leave at three o'clock in the afternoon, spend the night in North Adams, and return to Boston the next morning, reaching here about half-past nine. If any of the members desire to take that trip, if they will leave their names here with our Secretary, and the names of the roads represented, we shall be very happy to furnish transportation for themselves and ladies; or, if any members desire to return home that way, if they will leave their names here, I will see that they have transportation furnished them by that road. [Applause.]

THE PRESIDENT—Our regular order of business now is the Report of the Committee on " Driving-Wheel Brakes, to what extent is their use advisable, and the best method of their application." If Mr. Woodcock will kindly take the Chair, I will assist the Secretary, and read the Report, as the Chairman of the Committee.

[First Vice-President Woodcock then took the Chair, and President Barnett read the Report referred to, which was, on motion, accepted.]

REPORT OF COMMITTEE ON DRIVING-WHEEL BRAKES, 1886.

GENTLEMEN: A thorough and satisfactory discussion of the value and suitability of any of the mechanical appliances for securing brake-power, is possible only after a clear conception is obtained of the nature of frictional resistances as shown by experiment; and the most important point to be borne in mind, is the difference in the character of sliding and rolling friction.

Sliding friction (that of all shafting and axles in their journal-boxes, and cross-heads on slide-bars) is a varying but always large and measurable quantity, comparatively low in amount at high velocities and increasing in amount as velocity diminishes.

In the rolling of a cylinder on a plane, even if the surfaces are not as perfect as those usually provided for sliding, the frictional resistance resulting is very small, and the relative motion is *not* that of one surface rubbing past another, so that it is quite proper to say, that at the actual point of contact between circle and line these extremely limited surfaces are for the moment at rest with

reference to each other, or to say they are moving at equal and similar speeds.

Hence, the positive resistance to motion, due to the contact of wheel with rail, may, for our purpose at least, be considered *Nil*, as long as ordinary conditions prevail. But the primary object in the application of brake-resistance is to disturb these ordinary conditions, so that the touch of wheel on rail, instead of being a rolling and therefore almost frictionless contact, shall become that of sliding or rubbing at very low velocity, thus securing the highest coefficient of frictional resistance possible between two given metallic surfaces moving on each other, and achieving the final result of bringing the train to rest in the shortest time and distance.

For with engine and train in motion, all that we can do to bring it to rest, is to create additional friction; and that of the brake-block on the tire is only a means to an intermediate, most necessary but (as our Patent-office shows) not self-evident end; viz: the creation of friction between rail and wheel, the two surfaces that are in rolling (or equal speed) contact, but that must be put into slow-sliding contact; for, although the sliding friction of block on tire will soon destroy the centrifugal motion of wheel and axle, centrifugal force forms but a small fraction of the momentum tending to keep the mass in rapid horizontal movement.

We need not go to the mathematical labor of getting the square of the center of gyration of a hollow-spoke cast wheel, (which would be necessary for any close comparison), but it can safely be said, that in the worst case the centrifugal power in the wheels (tending by their rotative contact with rail to keep the train in motion), is at any speed, but from 5 to 7 per cent. of the total momentum or power requiring to be neutralized by the opposing brake; the remainder of the brake force, if properly employed, is used in producing sliding at low velocity or destroying rolling contact between tire and rail, this being its main and legitimate duty. Therefore any force or mechanical combination, other than the applications of brake-blocks, may be used if it will result in producing this difference in *touch* between tire and rail; as our object is to change the contact from rolling to sliding, yet at the same time keep the sliding velocity exceedingly low, because the lower

the sliding speed the greater the frictional resistance. It is now self evident why we endeavor to avoid skidding the wheels; as, when that is done, although tire is certainly sliding upon rail, the velocity of this sliding is high and the co-efficient of friction correspondingly low, and the resistance to neutralize the momentum of the train is low.

Thus the locking of the wheels, although it looks so effective in the eyes of a green employee, and has often been the object aimed at, by quite as verdant a patentee, is a gross mistake; in effect not only injuring rail and tire, but absolutely lessening the frictional resistance between them, which is all we have to depend upon. The maximum is attained when the wheel is revolving with a peripheral speed *almost* but not quite equal to that of the train, and no further resistance to motion with the modern train equipment is possible. Our object then in the application of brakes is to attain just this slight difference in the nature of the touch between tire and rail; more we cannot get, and less is a defect.

Possibly it might assist in opening a discussion on the theory of brake resistance if the members gave their opinion on the following actual case:—a train on a long falling grade became uncontrollable; the ordinary brakes and the driver-brake not proving sufficient to check the speed, the engine-man reversed the engine and opened regulator-valve without releasing the driver-brake. Do you think he should have released the driver-brake before reversing? Two elaborate reports were made on this case, one approving the man's action, the other disapproving and holding him responsible for the accident that followed.

Before giving the substance of the replies to our circular of inquiry, it would perhaps be advisable to give a few historical notes on the application of driver-brakes. In 1855 the Baldwin Co. affixed them on an eight-wheel coupled engine for the Mine Hill R. R. of Pennsylvania. There were blocks on the two back pair of drivers, actuated by a shaft across the engine, the shaft being operated by a chain and windlass. The earliest English application known to your Committee was in or previous to 1848, by Sharp of Manchester, who on a tank-engine applied wood blocks between the single driving and small trailing wheel, having wedge

links (or toggle-joint) actuated by vertical screw and horizontal hand wheel on foot-plate; this arrangement, although it applied but one block on each of two wheels of unequal diameter on one side of engine only, is to-day a model of neat design and proportion. D. Gooche in 1850 used a sled-brake, about 5 ft. long, to ride on rail between driving wheels, actuated by hand-screw and toggle-joint; but it proved neither safe or effective. One reason why neither this nor W. B. Adam's skid-brake shoe (sliding down to rail on a diagonal frame-bar) proved effective, we now know to be from the same cause that skidded wheels are not effective in giving the fullest resistance to motion, viz: the velocity of the surfaces in contact is too high, and therefore the co-efficient of frictional resistance is low. As early or even before 1837, John Melling of the L. & M. Railway, George Stephenson's first Master Mechanic, designed and experimented with a contrivance for utilizing, in emergency, the adhesive power of a second pair of driving-wheels, without the use of side-rods, *i. e.* steam pistons; working in small brass cylinders, on each side of boiler, were coupled to a transverse axle carrying on each end a free running wheel or idler. These small idler wheels when required were forced into frictional contact with and between the tires of main driving and trailing wheels. This device, although not a successful expedient for allowing an engine to be worked either with the freedom of a single driver, or with the extra adhesion due to coupled drivers, was fairly, but unexpectedly, a success as a driver-brake; however, the low speed and limited traffic of fifty years ago, rendered a driver-brake practically superfluous, and the material soon found its way to the scrap-heap.

In answer to the Committee's query, "Should brakes be applied to the wheels of all engines?" nineteen said yes, on all drivers; three would like to restrict them to freight or switchers; and two are more or less opposed to their application; a few saying they have no experience or know of no satisfactory brake. Of these replies (to the disgrace of our lazy members be it said) eight were from engineers not members of this Association, but representing an experience with many thousand engines, and if the replies in general be not treated numerically, but be considered as the casting of votes equivalent to engines represented, they show an overwhelming

majority in favor of the application of brakes on all engines. Mr. Lockwood lent us the official Board of Trade Returns for 1884, showing in Great Britain a total of 4,177 locomotives so equipped (a personal recount makes the total 4,183), divided as follows: various forms of vacuum, 2,990, Westinghouse plenum, 1,049, steam, 59, and all other types, 85; also it should be stated that in some cases engines are provided with two or more sources of brake-power, as vacuum, steam and hand power. It would be of interest were official American statistics available for comparison. Mr. Stevens reports on the "Lake Shore" 90 Westinghouse and 364 steam. Mr. Swanston recommends each railway to use one system only, as it entails less confusion, less risk, less expense and less duplicate material for repairs. The motives and reasons for recommending the application of a driver-brake, which certainly does not lengthen the life of an engine considered simply as a power-producing machine, are various. Some think, that as the whole weight gives momentum, as large a portion of the total weight should be braked as possible. Some say their great value and only service should be for use in emergency stops, whereas others would use on passenger engines because they should stop quick, on switchers because they stop very often, and on freights, because freight-trains are deficient in brake power at best of times. Another consideration is the lighter duty falling on to car draw bars, which are often said to be strained when all the brakes are in rear.

Granting, then—by reason of modern high speeds and density of business—the traffic necessity for driver-brakes, what are the points that discourage their application? Do they increase the cost of working by lessening tire mileage? Of replies received eleven say yes, or think so; two say do not know or think not, and eight say definitely they do not, a few of the latter going so far as to say, that if the proper form of shoe is used, so as to bear upon that portion of tire tread and flange not worn by rail, an *increased* mileage can be obtained.

Do driver-brakes lessen engine mileage between repairs? Four reply yes, or think so; eleven no, not much, or think not; one reports a tendency to fracture axle-boxes, etc.; four say yes, if wedge type but not if compression type is used, or pressure is equalized; and five ignore the query.

On the general question as to the coupling-up of the brake-gear throughout the whole train, its automatic action on drivers, or whether it is advisable to allow a conductor to apply brakes on drivers, opinions vary much: but there is a general feeling in favor of engine-men having the opportunity to apply the whole brake power, restricting the application by conductor to cars, or cars and tender only; that is, no one in rear should have the opportunity of applying brakes on drivers while the engine is under steam. There are three contra votes; one (the Pennsylvania Railway) being actually equipped so that automatic action applies driver-brake.

Opinions on this point were asked in view of a free ventilation by discussion before any Legislature should take hasty action upon it, or before any Court take the ground, that if the engine-brake be not coupled up and workable from rear, the possible maximum of safe brake resistance to motion is not in the hands of the train staff, and therefore hold the railway company in damages for criminal neglect; and in this light it is curious and interesting to note, that a large, if not the largest, Railway "Trades Union" has since the issue of our circular published a memorandum of 23 requisites that in their opinion are necessary for the safe working of railways. No. 9 reads, "All passenger trains ought to be provided with an efficient, automatic continuous brake, having brake blocks upon the wheels of the engine, tender, and every vehicle throughout the train." If so strong a statement comes from a large class of railway employees, we need not be surprised should the matter be legislated upon without much consideration, or much expert evidence being taken. Therefore the present moment is opportune for its discussion.

Among the replies were the following statements. Mr. Aspinwall said: "Any form of automatic continuous brake should be capable of being applied by the conductor on all vehicles, as well as by the engine-man." Mr. Ely: "In a general way, I would say, that as the traffic on our principal railways, and the speed at which trains are run, has so greatly increased as to require extraordinary facilities for controlling the movement of trains, and as these facilities are, as far as we know, limited to the weight of the

equipment, the retarding force should be applied to all available parts of the train, and to make the breaking power of the equipment most efficient in case of emergencies it should be kept in daily use." Mr. Atkinson: "The application of brakes by conductor should be as rare as possible, and should be *subject to gradation* exactly as by the engine-man, so that he need not, and should not, apply the whole force unless in emergency; there is then no objection to the conductor's power of applying brakes extending to the tender and engine, but it is rather beneficial than otherwise, as he could not strain the couplings behind the tender. Of course the engine-man would detect the application almost instantly, and would shut off steam."

Question No. 9: "Is there any danger in using a powerful brake at the front end only," was asked, with the intention of finding out if the opinion held by some, and well expressed by W. S. Huntington (see letter in *National Car Builder*, Feb., 1885), was a general opinion. He says: "When a train is running down a grade on a curve, and no brake power is available on the middle and rear portions, powerful application of the brakes to the locomotive, and a few of the forward cars, causes the flanges of the wheels upon which no brakes are acting to be thrown forcibly against the outer rail, causing mounting or spreading of the rails and derailment. This is the natural result of centrifugal force, combined with the suddenly checked momentum of the cars not held by brakes and having no hold on the rails other than the ordinary rolling friction; that is to say, the portion of the train that is suddenly checked is a dangerous obstruction to cars that are not held by brakes, by reason of their tendency to crowd each other past the obstruction in a tangent, assisted by momentum and centrifugal force."

Also, it is noticeable that many cases of derailment occur when an engine is not working steam, especially is this the case with six-wheel coupled truckless engines, moving round sharp curves. Engines will go safely over a quick curve if exerting a *pull*, that cannot be certainly counted upon to keep the track if it is propelled in front of some other motor; and even on straight track, few railway offices freely permit the backing up of a train in

advance of its engine, and there is legislation forbidding trains being run with engine having tender first.

The explanation for this may not be single or simple in character, but it would appear as if the internal propelling power must be greater than the internal and external resistance combined, to ensure safety under the given conditions. If driver-brake, and that only, is applied the mass of the train will then give the forward momentum, or be the propelling power, and the engine wheels will give the frictional resistance in front of the power, subjecting them to possible derailment. This is apparently an element of danger; but whether the hypothesis be a correct view of the case or not, it is satisfactory to find not a single case of trouble due to the application of driver-brake only is recorded in the answers received, while eighteen state definitely that in their opinion there is no danger, Mr. Worsdell adding "especially when cars are coupled slack." Mr. Aspinwall believes there is danger if application is sudden, and he uses a smaller air ejector to obtain a vacuum on freight engines. Mr. Cushing says: "On engine alone there is an element of danger, except used with care, * * * * especially if considerable slack in couplers."

What percentage of the total weight of the engine can effectively and safely be utilized for brake resistance? If there is no risk or danger in locating a powerful resistance forward of the moving body, no attention to this question is necessary, unless the brake is automatic in application when train separates. In considering this latter case, it should be remembered that it is not judicious, in arranging the lever proportions for any cars, to count upon utilizing more than the tare or empty weight; otherwise, if arranged to take advantage of the increased weight when more or less loaded, then if brake blocks be applied to wheels when car is actually empty the effect would be to promptly skid them. Hence, if the engine brake is designed to utilize the whole of the weight of engine and tender, and the detached cars in rear be heavily loaded, the latter will—after the brakes have gone on automatically—move with a higher speed than the front end, and eventually collide. Such a rear pitch-in could only take place when the brakes on engine and front cars, utilized for resistance to motion, a greater percentage of the

total dead weight resting on the braked wheels than was utilized on the rear portion. Some engines have blocks on all wheels—and tank-engines lend themselves readily to such an arrangement—but care should be taken to arrange the leverage so as not to utilize the whole insistent weight, if the application is to be automatic.

To the somewhat crude question of what percentage of weight on drivers should be utilized? one reply says 7 to 10 per cent.; another, 45 per cent. on engine and tender, with 100 per cent. on cars; a third, 50 to 60 per cent.; a fourth, 80 per cent.; a fifth, 75 to 90 per cent.; a sixth, 95 per cent.; and a seventh says, twice the weight on drivers, or 200 per cent. Captain Galton's experiments—which are now classic—prove that speed is the most important factor in this equation, 200 per cent. being safely used at high speeds of 50 or 60 miles per hour without skidding the wheels, but the pressure must be lessened as the speed lessens, if skidding is to be avoided.

In the matter of brake-block shoes, their substance, size and shape, six are in favor of cast iron, seven of wrought iron and the American Co. says 95 per cent. are of wrought iron; two approve of the Congden, while one prefers wrought to Congdèn. Mr. Webb says, "The best results we obtain from wood blocks when they can be conveniently applied. Those we have in ordinary use are of English poplar about 18"x3½", the face is perforated with fine 1⅛" holes, which are afterwards filled with a mixture of resin and sand." And Mr. Johann, while preferring wrought iron, has obtained excellent results from a head filled with hard wood blocks, as per drawing No. 1 attached. The Eames Co. say "that material is to be preferred which yields the quickest stop, with due regard to economy, durability and effect upon the wheels. Cast iron presents a greater frictional resistance than wrought iron, inasmuch as it granulates and retains a certain degree of roughness throughout the life of the shoe, instead of becoming smooth and polished, as is the case with wrought iron. The wear upon the tires is undoubtedly greater with cast iron than with wrought iron, but this is the necessary result of its greater braking efficiency. The more effective the brake the greater the wear of both shoe and tire. The same principle of efficiency applies to the comparative cost of the two materials. The wrought iron shoe has a longer life, and inde-

pendent of the work performed, is cheaper; but when the actual braking power furnished by each is taken into account, cast iron is the most economical."

As to amount of surface, the American Co. averages 60 sup. in. Two replies give a maximum of 88″ and one a minimum of 36″ or a difference in length varying from 22″ to 9″. The Eames Co. say they "favor the greatest length of shoe that can be conveniently applied. The longer the shoe the less frequent the replacement. The frictional resistance being the same whatever the length of the shoe, the greater the surface of the shoe, the greater the distribution of the wear and consequent life of the shoe. The same principle applies also to the thickness of the shoe; the thicker, the greater the durability. As a matter of practice, having regard to all these points, we make our shoes of a length equal to three-fourths of the radius of the wheel. * * * * Our experience is opposed to the use of channelled shoes because of their liability to cut into the tire. * * * * But it is an advantage to have shoes fitted well over the flanges," and five replies endorse this latter statement.

What is the position of block giving greatest efficiency and least interference with the elastic freedom of springs? Mr. McCrum sends a blue-print showing position at angle of 24°, or with block 22″ long the top is 2½″ below centre of wheel. Mr. Cook says toe of shoe should clear rail 4½″. The reply of five is top of shoe should coincide with centre, and two say, centre of block and of wheel should coincide. Many accept the positions given by the Brake Cos. without question, and these being familiar to all need not be specified. Mr. Atkinson says, "the wedge type should be 45° from vertical, as if too high they tend to throw the pressure on the side of the brass where the blow and wear from the steam thrust takes place. * * * The application of one block at side of wheel interferes with the action of the spring in the proportion that it is effective, the compression type with blocks directly opposite interferes least with spring action. Single blocks on top of wheel would carry part of the load and thus interfere with spring elasticity, if placed on the centre of the rising side would tend to act similarly in decreasing load on spring, while if on the falling

side would tend to increase the load on spring." The Committee generally endorse Mr. D. Clarke's statement, that they should be as much below centre as possible, allowing safe rail clearance.

The modes of applying blocks, their number, their position and the choice of wheels they are applied to, is legion. J. Haswell, of Vienna, on a ten-coupled tank-engine, in 1862, tried blocks on the top of the second and third pair only. Apart from the question of interference with spring action, it is a fair inference that the inequalities in rail surface severely tested the brake-rigging, despite the fact that the power was given through the elastic medium of two steam pistons.

An examination of 110 drawings showing engines equipped with driver-brakes gives the following analysis, viz.: 37 are wedge type, that is they force adjacent axles apart, and 3 force out coupled but not adjacent axles; 10 are of the compression or grip type, with blocks on both sides of one or more wheels, and 6 compression type on opposite sides of coupled but not adjacent wheels; 45 with one or more single blocks in front of wheels (block in going on moves backward) and 9 with one or more single blocks at back of wheel (block in application moves forward). Many of these drawings represent shunting and tank engines, and 17 have every wheel, drivers or carriers, provided with brake shoes.

Many attempts have been made to obtain a driver-brake through resistance offered to piston movement, without the destructive effects which commonly accompany steam-reversal. Closed exhaust nozzles have been used, so arranged that piston had either vacuum behind, or excess pressure in front, and even compressed air has been admitted in front of piston. The most successful of these schemes,—one that has been at work for twenty-one years, and which continues to be applied to new engines on the French and Belgium railways,—is the counter-pressure brake of Le Chatelier, which achieves its resistance—after the reversing lever is thrown over—by the introduction of a small jet of boiler water from an opening of $\frac{1}{10}$ to $\frac{1}{8}$ square inch area, delivering from 8 to 40 pounds of hot water per minute in the cylinder exhaust passages, which, on release, flashes into wet steam, and being drawn into cylinder by piston cools the metal it comes in contact with; the general tendency

of other counter-pressure brakes being to heat and cause excessive friction between the moving parts. If sufficient water is admitted part of this steam escapes from the exhaust nozzle, thus fully insuring that from smoke-box no dust shall be drawn into contact with bright metal faces, or gases drawn in and then forced into boiler. A small brass valve and 1¼″ pipe are the total equipment required for this brake, which is very effective in checking speed and keeping cylinders well lubricated on down grades, and it can be relied upon for instant application as long as there is hot water in the boiler. The earlier attempts to inject steam instead of water were not successful, and even mixed steam and water called for too much discretion in application to insure its extensive use.

Mr. Cushing uses driver-brake on long grades only as auxiliary, their tendency being to heat and loosen the tires; and it is for steadying on long down grades that counter-pressure has proved so effective.

A handy, effective, and well arranged driver-brake—open, it is believed, to general use—as designed by Mr. H. Wallis for shifting and branch engines on the G. T. Railway, is shown [see Plate No. 20], which is believed to be self-explanatory, but if not so the Committee will gladly answer any inquiries.

Mr. Gurnsey, agent for the "Beal Brake," forwarded drawings [See Plate No. 21], illustrating the application of that patent. It will be noticed that by a neat arrangement of fixed and floating levers, with single connecting bars (which can be of small section as they do work in tension only), the shoe pressure is put in equilibrium throughout, and as the shoes clasp the wheels the strain either on frames or machinery is very light. New shoes, replacing those worn out, can be slipped into place any time without disturbing to any great extent the equality of pressure throughout the series, and the single series may include both tender and engine wheels. The parts are light, easy to manufacture, and largely duplicated both for tender and engine, as well as for different classes of engines.

Our thanks are due, not only to members, but to the following gentlemen and firms, who, although we had no legitimate claim upon them, kindly contributed information, drawings, etc., viz.,

the American Brake Co.; J. A. F. Aspinwall, G. S. & W. R'y, (Ireland); R. Atkinson, C. P. R'y, (Canada); R. Boaz, G. T. R'y; Eames Brake Co.; T. N. Ely, P. R'y; W. B. Gurnsey; H. Roberts, C. & G. T. R'y; C. Sacre, M. S. & L. R'y; H. Wallis, G. T. R'y; F. W. Webb, L. & N. W. R'y; T. W. Worsdell, N. E. R'y.

Since the foregoing report was written, J. S. Cook, G. R'y., sent us a print and description (herewith attached) of Cosgrave's Patent Valve, used with Westinghouse equipment, to apply brakes to train or driving wheels, either separately or together as desired:

DEAR SIR—Your favor of the 24th inst. to hand. In reply will say, I enclose blue print of the valve we use to separate Westinghouse Driver from train, tender and train brakes. This device is patented by E. J. Cosgrove, of this city. [See Plate 19.]

DESCRIPTION.

Figures 1 and 2 are full size top and side views of the valve coupled up to a Westinghouse Engineer's Valve showing method of attaching valve and piping to the same.

The cams "B" and "C" are made in one casting and fastened to front end of the handle "E" by countersunk screws.

Fig. 3 is a sectional view of valve when the main valve "G" is opened; it is done by pressing on stem of valve "K" and closing it down on its seat. When valve "G" is open valve "K" is closed and when "G" is closed "K" is open.

OPERATION.

When handle "E" is in release or running position, valve "G" is held open, thus allowing driver-brake to be applied from train while handle "E" is in that position. When handle "E" is moved towards the right to apply brakes, as soon as shoulder "M" is passed, the cam "B" releases "G" and allows it to seat itself, thus cutting off driver-brake and applying tender and train brake at same time. *To apply driver-brake* move handle "E" to the right until cam "C" comes in contact with valve "G" and moves it off its seat allowing compressed air to pass into driver-brake cylinders and apply brakes.

The cams "B" and "C" are so located that cam "B" releases

valve "G" before handle "E" moves far enough to apply brakes, and cam "C" does not come in contact with "G" until handle "E" has moved far enough to apply tender and train brakes with full force, thus enabling engineer to apply tender and train brakes without driver-brake or also driver-brake simultaneously by same handle.

To release driver-brake alone, bring handle "E" in or about the position shown in figure 1. This allows valve "G" to seat itself, cutting off communication between driver and tender brakes. When this is done the compressed air in driver-brake cylinders coming through the openings "H" moves valve "K" off its seat and escapes through the opening "L" thus releasing driver-brake alone.

I hope the information furnished may be of service to you and apologize for my long delay. We are very busy, getting ready to change the gauge of this road next Tuesday, from 5 feet to 4′ 9″, is my excuse for delay.

Hoping to be able to meet you in Boston next month, I remain,

Yours very truly,

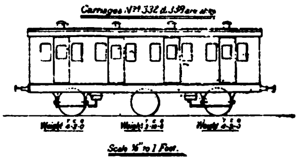
JOHN S. COOK, *M. M.*

Through the kindness of W. W. Evans, C. E., and associate member, we are able to give some information as to the slight wear on steel tires, gripped with brake-blocks, over and above usual tire wear; and although not direct evidence as to the effect of driver-brakes, an examination of Plate No. 22, attached, will prove interesting. It gives the grouping of and the weights on the wheels, the number of stops made and the absolute wear of tires (braked and unbraked) under the same coach. The wear is so nearly equal, that it is impossible, by simple examination of the outlines as worn, to say which tires did braking duty.

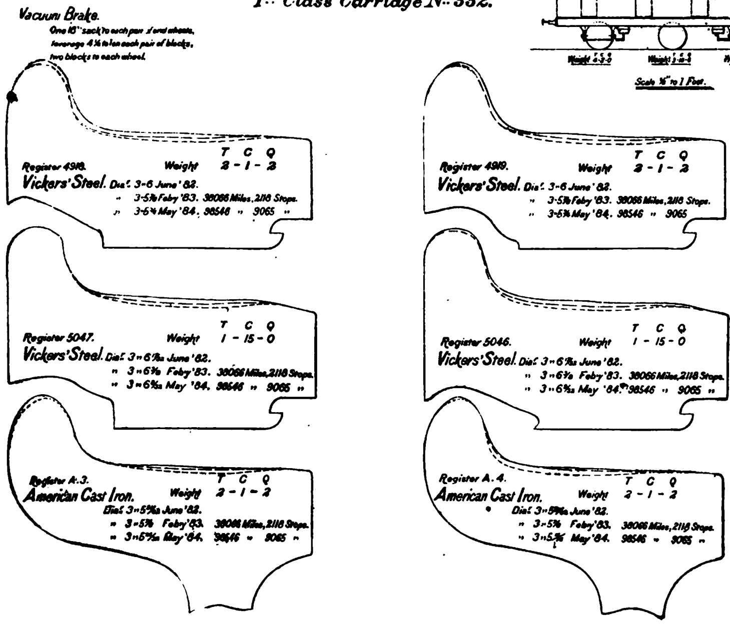
J. DAVIS BARNETT.
H. A. WHITNEY.

CHAIRMAN WOODCOCK—The subject is now open for discussion.

PRESIDENT BARNETT—The document is longer than it should be, and I would not have introduced the historical section of it if it had not been for the fact that part of it was never in print before. That about the driving brake of 1837, is certainly not on record elsewhere. The Committee introduced that as a proper introduction, which made this Report



1st Class Carriage No. 332.



1st Class Carriage No. 338.

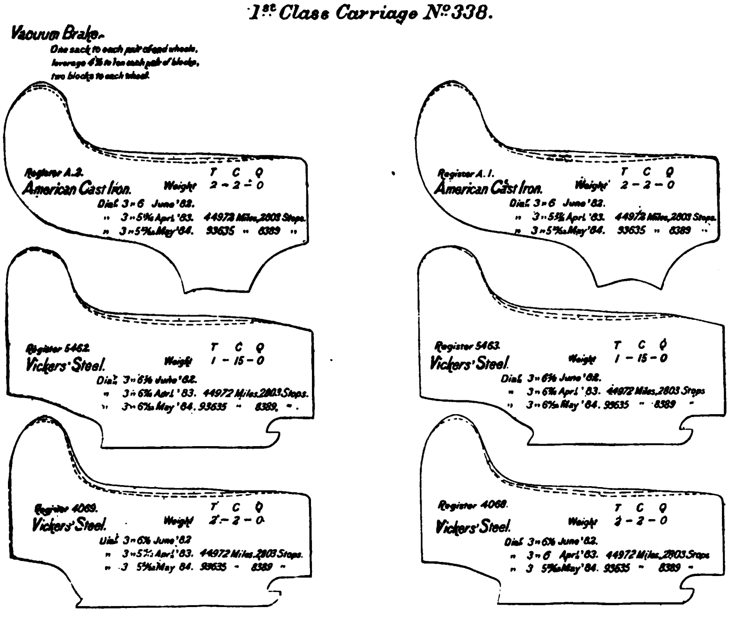


Plate 22.

somewhat extended. There is not much contradiction in the Report itself, nor in the replies; but generally the sentiment in the replies is that the driver brakes ought to be applied on as many wheels as possible; and there is no danger in the hands of any careful engineer in their daily use.

H. A. WHITNEY—I would like to ask members of the Association who have driver brakes in use, what their experience is in regard to the wear upon the axle-boxes and the side-bar bearings. With us, our experience has not been altogether satisfactory. It gives us continual trouble. We have about fifty engines equipped, and we are now putting it on one hundred; but in a different way.

J. N. LAUDER—I hope I am not laying myself liable to the charge of talking too much and wanting to discuss all these questions; but while I cannot give any reliable data to answer the questions that Mr. Whitney has asked, still there is one thing that I think should be considered, and that is, in applying driver brakes to passenger engines, whether they should be applied to be used in making all ordinary stops, or whether they should be held as auxiliary, as a safety appliance, so that in case of an emergency you have got something beyond the usual appliance for stopping a train. I am aware that roads in this country are divided on that question. Some believe that they should be made to do their proportion of the stopping of the train whenever the train is stopped. That, from one stand-point, is all right, but when you do that you have nothing as an auxiliary brake, you have no reserve power to use in case of an emergency; whereas, if the driver brake is separate from the automatic train brake, and is only used in an emergency, you always have then a reserve power in case it is required. Of course, if the driver brake is used to make the ordinary stops, engineers will soon learn that they can make a stop a little quicker with it than they can without it; and, consequently, the full braking power that the engineer has under his control is applied at all times. Now, in case he finds himself running by a station, from some cause, he has got to run by; he is using all the braking power he has got in making that stop. Or in case he is likely to drop off at a switch that may be wrong, or have a collision with an approaching train, or a car that may be in the way, he is using all the power he has got in making his ordinary stop; and evidently he will do damage that might be avoided if he had a little reserve power back to meet such an emergency. My own practice is to use the driver brake as an emergency brake. It was formerly used on the Old Colony Railroad as an ordinary brake; but I have changed, and now we use it simply as an emergency brake. We are equipping all our trains with driver brakes as fast as may be, both freight and

passenger. Of course, on freight trains the driver brake is used at the discretion of the engineer. The question that Mr. Whitney brings up is very important; and if anyone here has any facts to present in regard to it, I should like to hear it, because the majority of brakes, I suppose, are simply a wedge brake between the driving wheels.

MR. BALL—Mr. President, on the Elevated Railroad, you are aware, we make a good many stops. Our engines are all equipped with the Ames' Vacuum Brake. The driver brake is an independent or auxiliary brake. Before equipping the road in that way the engineers were in the habit of using the driver brake all the while, and the result was that with thirty engines I have got twenty-six broken driving-boxes, caused by the use of the driver brake. I went on the road myself one day and tried to brake, and I broke two driver boxes myself applying a driver brake. Since then we have abolished its use except in case of an emergency. We think it is cheaper to keep up good brakes on our cars than to keep our motive power up. I think the driver brake is a good thing on an engine, but, as Mr. Lauder says, where the engineers get in the habit of using it all the time to make their stops they get careless, and in case of an emergency they have nothing really to fall back upon.

JACOB JOHANN—I have not very much experience with driver brakes, although I have some in use; but I beg to differ with Mr. Lauder and Mr. Ball. I believe the driver brake is a good thing to use at all times. In my experience I haven't had any such difficulties as they speak of. The first I had in use I put on in 1874, and they ran along without any trouble. It was used to make every stop the same as the train brake was.

I paid more attention to it, with that engine, than with others we had subsequently, and, the fact is, the tire of that engine wore better than engines that did not have the driver brakes. So far as the difficulty which some of the members dread so much, of the effect on the boxes and rods, I can only say that I have never experienced any of it. We had no more trouble with the side rods or driver boxes than with any other engines; and, in my opinion, that is just what we want, in addition to our train brake, and to use with our train brake. Then if the engineer will handle the brake properly he doesn't necessarily have to apply it so severely as he does if he does not use it. I believe it should be used at all times.

H. A. WHITNEY—We use the driver brake precisely as Mr. Johann says he uses his. Now, what is the object of a driver brake? It is to arrest the motion of a train. Because a man uses a brake at every stop, it doesn't prevent him using it in an emergency. If it is used

judiciously, I cannot see the objection to using it all the time if you have it there. The proportion of the weight of the engine to the train does not have such an effect as it does on a short train. If you have a short train then you want to put the driver brake on, certainly. For that reason we use it. Then there are emergencies that arise. For instance, an axle may break, or a wheel may break. There is a case where I think the advantage of having driver brakes comes in.

D. O. SHAVER—I think the driver brakes should be used at all times. We use it on a great many engines in that way with very good success, in fact, on all engines. I do not see any trouble with our side rods and boxes. They do not wear out any faster now than they did before we had the driver brake. The driver brake, in my opinion, is put on to be used.

ANGUS SINCLAIR—I have run a great many miles using a driver brake, and my impression is, from very close observation of its action, that the brake-shoes had a tendency to prevent the tires from spalling on the outside of the flange. When the brakes were used between the wheels, in the ordinary way, I found that the front end of the forward driving-brasses were worn, and the back end of the back driving-brasses were worn, and it was decidedly harder on the side rod brasses than when no driving brake was used. I think that if it was applied so that it would take hold of each wheel independently, that it might be used without any of that action on the axle-box and side rod brasses. The experience which Mr. Ball had on the Elevated Road indicates in a very strong way what it is on a surface road, in a smaller way. We do not have the experience of having the axle box break by applying the brake, because they are so strong that they will sustain it; but it shows that the action must be there.

MR. BALL—I think it depends somewhat on how the brake is applied; the pressure on each shoe figured out is about 1,200 lbs.

You apply that brake suddenly, and you throw a blow of about 1,200 lbs. on each wheel. I contend that that 4,800 lbs. wears somewhat upon the boxes, and also upon the side bars. It holds equally true with a small engine, just as well as with a large engine. We plainly have a chance to demonstrate these facts better than you do on the large engines. With our engines we are restricted to a certain amount of weight. It shows it is detrimental when the brasses wear as rapidly as they do. If the brake can be applied on each side of the wheel, so as to hold each wheel in position, I do not see that it will injure your driving-box or side rods. The Brooklyn Bridge have engines equipped in that way. They use it continually in making their stops, of which they make a great

many hundred every day. They make a great many more stops every day than any surface engine in the country is subjected to. They don't experience any trouble, because they are equipped differently. Now, about the driver brake being used continually. I contend that where any engineer has a brake on his engine that he uses continually, in case of an emergency he is lost. We had a case on our road a short time ago where an engineer was running around a curve, and if he had not applied his train brake and driving brake, he would have run into another train; but he did apply the driving brake and he stopped his train. We have seen a great many cases of that k nd. Now, another case in regard to the driver brake. An engineer applied his train brake and, being a case of emergency, he applied the driver brake and then reversed his engine. He had locked his wheels and slid into the rear end of the next train. In that case he flattened the wheels, and I hadn't any facilities for turning off the tire, and I had to do something about it. And what did I do? I allowed the engineer to use that driver brake continually; he wore that flat spot out of the wheel, and the engine is running to-day, that is a fact about turning up tires with a driver brake.

JACOB JOHANN—I can see, of course, that there may be some mechanical difficulties in the construction of the brake. The question is, as I understand it, Is the driver brake desirable to have? On that question I say yes, it is, and so far as my experience goes, it is desirable to use it at all times. Of course, if gentlemen have extraordinary routes, why, then, it may be desirable to change its use.

MR. BALL—I wouldn't have an engine on our road without a driver brake, but I say it should be an independent brake to be used only in case of an emergency. There should be some way of cutting it off instantly. With the automatic arrangement that the Ames' Vacuum Brake has it is very easy to cut out or instantly apply it, and the Westinghouse Company ought to apply their brake in the same way.

JACOB JOHANN—I have a little incident to relate in relation to brakes. During my career I was connected with a certain railroad where they had an air-pump on the engine, but they had no driver brake nor even any brake on the tender. I inquired why they didn't have any brake on the tender, and they said that it wore the wheels flat, and that was the reason they didn't put it on the tender.

CHAIRMAN WOODCOCK—It has been suggested that Mr. Hackney, of the Union Pacific road, is here, and may be able to give us some information.

GEORGE HACKNEY—We are using the Le Chatelier brake on our road. We use our driver brake all the time connected with the cars, for this

reason: A great many cases, we find, where it is an independent brake, they lose control of it by reason of its being out of order, and when an emergency comes it is of no use. Our Le Chatelier brake is as described in that report. We use it all the time on our mountain road. We regard it as a very fine thing. I think if it was better known it would be more generally used.

PRESIDENT BARNETT--I had hoped to bring some evidence on this point from the practice of the Canada Pacific Railway. They have found nothing that satisfies them in going down the long grades like the Le Chatelier brake. The master mechanic who promised the communication has had a very close practical experience on these grades, but for some reason his letter has not reached me. In the ordinary form of driver brake used on a long grade it has the effect of warming the tire so as to cause it to slip. You get rid of that very serious defect completely by using the Le Chatelier brake, and I would only recommend it under those circumstances where the application of the brake is so continuous that injury might result, due to the friction generated between the shoe and the tire. On the question as to the relative value of grip or clip brakes used, and wedge or expansion brakes used, Mr. Webb, of the London & Northwestern Railway, said, in his letter to the Committee, that he had very ample experience with both types, and he was not prepared to say that he would recommend a grip type in preference to the wedge type.

GEORGE HACKNEY—I wish to state further that the mountain that we use the Le Chatelier brake on has a grade of 185 feet for nine miles, on each side. We have heated tires with the Westinghouse brake hot enough to throw off on that grade.

J. N. LAUDER—Then I should understand that the Le Chatelier brake, or so-called water brake, would be only recommended for use where the grade is very heavy, and for a long distance. I can readily see that it must be a splendid appliance to be used in passing over such mountains as the Santa Fe road has, and as other far western roads have to contend with. I presume from the evidence that we have here, that that type of brake would be very well adapted to that kind of service. Now, with reference to this question of using the driver brake to make all kinds of stops and to be used at all times, I believe that the driver brake on passenger engines should be used as an emergency brake—not that I believe that the brake injures the engine to any great extent, but I believe that on passenger trains where there are a large number of stops to make, that we should have something back to use in case of an emergency. Now, I draw these conclusions from the fact that I am connected with a passenger road that has an immense suburban traffic,

where a large number of our trains have to make a great many stops, and having had several unpleasant experiences where an auxiliary or reserved brake would have prevented them, I believe that I am justified in using the brake as it is now applied. The cost of maintaining and putting on that brake would be wiped out very quickly by the accidents which this appliance would have prevented. Of course, the statement which Mr. Hackney makes contains considerable force, in that the engineers will not keep the brake in order unless it is used occasionally. I have never experienced that trouble, because I find that the moment the engineer moves his engine from his train—the engine alone—he uses that brake. So that I never have experienced any trouble by having the driver brake get out of order for want of use.

A MEMBER—I would state that two years ago the road that I represent here made some experiments in reference to the increased wear on driving-boxes and side-bars, owing to the use of the driver brake. We put two engines in the same service. Our road has very heavy grades, and I made it my business to travel on these engines, the one equipped with the brake and the one not so equipped. I never found any difference at all. I would like to ask Mr. Hackney if this water brake that he has in use is also applicable to the cars, or does he use the Westinghouse brake on the cars?

GEORGE HACKNEY—We use the Westinghouse air brake on the cars, but it is not applicable on the heavy grades that we have.

A MEMBER—I was thinking that a road that had heavy grades, when the brakes were applied that rendered the tires hot enough to drop off it would also be very disastrous upon cast iron wheels.

GEORGE HACKNEY—It does not apply to the wheels. The Le Chatelier brake is a brake that puts hot water in the cylinder.

J. N. LAUDER—In reference to that, on a freight train or a passenger train, on a grade of 185 feet to the mile, it would need something more probably to make it safe than the ordinary appliance that we have in stopping the train. I think I have knowledge of some freight trains on Mr. Hackney's road getting away from them and going down the hill in spite of all the braking appliances they had.

[On motion, the discussion of this report was closed.]

[President Barnett then resumed the Chair.]

The Secretary has the report of the Auditing Committee, which he will read.

[The report referred to was then read, and, on motion, received.]

To the American Railway Master Mechanics' Association:

GENTLEMEN—The Committee appointed for the auditing of the Secretary and Treasurer's accounts, find them correct, and according to their respective reports. Respectfully,

G. W. STEVENS,
H. TANDY,
N. W. HOWISON.

THE PRESIDENT—Of the Permanent Committee on Subjects but two members are present, Mr. Twombley and Mr. Blackwell. If any member has a subject that he wishes to suggest for discussion next year, will he please communicate it to either one of those gentlemen.

R. H. BRIGGS—I move that we now adjourn until Friday morning at 9 o'clock.

L. FINLEY—I second the motion.

[The motion prevailed, and the Convention adjourned to meet at 9 o'clock on Friday morning, June 18, 1886.]

THIRD DAY.

President Barnett called the Convention to order at 9 A. M.

THE PRESIDENT—The first report in order is that on "Balanced Slide Valves."

The report was read, and, on motion, accepted.

REPORT OF THE COMMITTEE ON BALANCED SLIDE VALVES.

To the President and Members of the American Railway Master Mechanics' Association:

The Committee appointed to report on Balanced Slide Valves, beg to submit the following, as the result of their inquiries:

A series of questions bearing on the subject and prepared by your Committee, were printed and distributed by your Secretary to members of the Association. In addition, a limited number of circulars were forwarded to Europe, and addressed to the leading Locomotive Superintendents of Great Britain, all of whom promptly replied to the questions asked. It is a curious fact that the replies from the other side of the Atlantic were, with one exception, all unfavorable to the use of balanced valves, whereas, the answers received from American Master Mechanics showed that balanced valves, as applied by them, generally gave little or no trouble and were considered successful. It may not be out of place to here mention that the earliest application of balanced slide valves reported to your Committee, was made in 1844, to engines on the Grand Junction Railway, now a portion of the London & Northwestern system of England, and shown on blue print here exhibited, and kindly furnished by Mr. F. W. Webb.

In reply to your Committee's questions Nos. 1 and 2, namely, "With what balance slide valves for locomotives have you had experience? please send sketch or drawing of same. Upon how

many engines were these valves applied? give date when the first of each description was placed in service." The following replies were received:

Mr. John Davis Barnett sends blue print, representing valves as used on the Grand Trunk Railway of Canada, and generally known as the improved Morse pattern. [See Plate 23.] 294 engines are now equipped, and the number is steadily increasing. The first was applied about nine years ago.

Mr. Allen Cooke reports having used a Richardson valve [Plate 29], and the old Morse valve (see Seventeenth Annual Report, page 115), on the Chicago & Eastern Illinois Railroad, the Richardson valve being applied in January, 1883.

Mr. D. Drummond states that the Adams valve was used on the Caledonian Railway of Scotland, but gradually abandoned fifteen years ago.

Mr. W. H. Harrison reports the Baltimore & Ohio Railway Company as having 135 engines equipped with the Beckert [see Plate 24], and one with the Richardson valve. The first were applied in April, 1885.

Mr. Thomas Jones used the Adams valve on the Highland Railway of Scotland. [See Plate 25.]

Mr. J. Manson states that the Adams valve is used on many of the outside cylinder engines of the Great North of Scotland Railway. [See Plate 26.]

Mr. J. Meehan reports having used the Richardson on 19, the DeLancy on 31, and Margach's balanced valves on 41 engines of the Cincinnati, New Orleans & Texas Pacific Railroad, the first of the DeLancy valves being placed in service in October, 1884.

Mr. Harvey Riches states that he has some balanced valves in operation on the Taff Vale Railway of England, but gives no further particulars.

Mr. C. E. Smart reports having used the Richardson valve on 18 engines of the Michigan Central Railroad, the first being applied in March, 1885.

Mr. George W. Stevens has used the Richardson and the Margach valves on the Lake Shore & Michigan Southern Railroad.

Mr. W. H. Stearns has 26 engines equipped with the Richard-

son valve on the Connecticut River Railroad. The first was applied in June, 1882.

Mr. P. Stirling, of the Great Northern Railway of England, states that he has used three different kinds of balanced valves, but does not describe them.

Mr. W. Stroudley, Locomotive Superintendent of the London, Brighton & South Coast Railway, states that he used the Adams valves on outside cylinder engines of the Highland Railway of Scotland, in 1866.

Mr. Thomas B. Twombly, Master Mechanic of the Chicago, Rock Island & Pacific Railway, reports that he has about 150 engines equipped with the Morse valve, as shown in blue print, the first having been applied in 1880.

Mr. F. W. Webb, Locomotive Superintendent of the London & Northwestern Railway of England, states that he has one pair of experimental valves in use at the present time, and, also, that several engines were equipped with balanced valves, as per blue print exhibited, in the year 1844. [See Plate 28.]

Mr. William Woodcock reports that he has, on the Philadelphia & Reading Railroad, 12 engines fitted with the Allen valve, balanced by the Richardson device, the first having been applied in February, 1882, and has also used the Bristol Roller Valve. Drawings of these valves were supplied to your Committee and are here exhibited.

In reply to question No. 3, "If you have had experience with more than one kind of balanced valves, please state which you consider on the whole the most satisfactory, and name the good and bad features of each valve," the following answers were received:

Mr. J. Davis Barnett reports that his experience is limited to three types. (1), The ordinary slide valve, with a cylinder cast on steam chest cover and in which piston works, coupled by pendulum connecting rod back of valve. This, which has been tried in all varieties and forms for the last thirty or thirty-five years, was not a success. (2), The Adams Annular balance on back of valve. This is defective by reason of the ring occasionally canting and immovably locking the valve, so that either valve buckle, stem, or some other part of the motion gets broken. Or conversely, the

ring dropping down, the blow-through of steam is excessive. (3), The type, as per blue print, has been fairly successful, care being required to use good steel for the coiled springs. Experience is also required on the part of the smith in tempering the springs so that they will stand up to their work under the variation of temperature to which they are subjected.

Mr. D. Drummond, Caledonian Railway, supplies tracing here exhibited showing extreme travel of valve when the train is under different conditions of load. A ridge was found to be formed at each of the lines indicated, and caused a considerable blow of steam when piston of the Adams valve rode over the ridges at extreme end of the travel corresponding to third notch of reverse lever, a position in which engines are probably mostly worked. The valves were abandoned on account of this difficulty and on account of the trouble they gave at outside stations in keeping them clean and in good working order, making the expense of their maintenance greater than that of the ordinary valve. Mr. Drummond refers to the piston-balanced valve introduced by the late Mr. Beattie, on the London & Southwestern Railway, but which had to be abandoned on account of the difficulty in keeping it tight.

Mr. Harrison considers the Beckert valve as more satisfactory than the Richardson, on account of its simplicity, ease of application and cheapness. So far, this valve has not developed any bad features.

Mr. D. Jones gave up the Adams valves on account of their loosing so much steam by blowing past the piston rings of the valves.

Mr. J. Manson states that, speaking generally, the results obtained with the Adams valve on the Great North of Scotland Railway are most favorable, so much so that since taking up his duties as Locomotive Superintendent he has increased the number of engines fitted with it, and is still adding to the number. A tracing of the valve, as used by Mr. Manson, is here exhibited.

Mr. James Meehan presents the following as opinion of his Division Master Mechanics, Tomlinson and Fowle: The former states that "of the Richardson, DeLancy or Margach valves, I have had more experience with the Richardson and consider it, if carefully proportioned and fitted, to be a fair balance, and owing to its ex-

treme simplicity, well suited for passenger engines. I do not think that if properly constructed and cared for there are any bad features worth mentioning. The DeLancy I have not seen applied to passenger engines, but on freight I consider it a first-class valve. Have had three engines running with it on my division for four months, but have never had occasion to touch the valve. My objection to this valve is a large amount of suction when steam is shut off, necessitating cutting the engine back when running light, and having a tendency to, in my opinion, increase the necessity for lubrication. My experience, however, has been with valves *when new* and it is possible, when worn free, that this trouble may not be so apparent. The valve is of good construction, and if suction, or the compression of air in steam-chest can be reduced, it should be a good valve on fast as well as slow working engines. It gives, so far as my experience goes, no trouble. The Margach valve is, in my opinion, if well constructed, as good a balance as any of the three I have described, as there is no wearing against the steam-chest cover or false upper seat when steam is shut off. Its bad features are the tendency of the nuts securing the balance pistons to valve to work loose and of the balance rings to stick or gum up, unless great care is taken to keep them clean. If this valve is well made and properly applied it should make a good balance and can be used without relief valve."

Mr. I. W. Fowle, Division Master Mechanic, states, "I consider the DeLancy valve the most satisfactory of the three. The bad features of the Margach valve are that the rings are held up against the chest cover by steam pressure only, and if the rings get gummed up or bound in any way it causes a bad blow on starting the engine. The friction caused by the rings coming in direct contact with the chest cover makes them wear very fast where they are fitted to the valve, and which necessitates frequent renewal. The bad features of the Richardson valve are that the packing strips come in contact with the chest cover, and the friction soon works the strips loose in the grooves in valves, making repairs necessary. The springs for holding up the packing strips sometimes break and cause a bad blow. With these exceptions, I consider the Richardson a splendid valve. The packing strips in the DeLancy valve have no wearing

surface, therefore give no trouble and do not have to be renewed, but we have the same trouble from occasional breaking of springs which hold up the packing strips that we experienced with the Richardson valves. Aside from the springs breaking, the DeLancy valves give no trouble whatever."

Mr. Geo. W. Stevens prefers the Richardson to the Margach valve on account of the former running a greater length of time before requiring repairs and thus crippling the engine, than the other.

Mr. William Woodcock prefers the Richardson balanced valve to the Bristol valve, as the latter is very difficult to adjust and expensive to keep in order. He states, "I have not furnished any data in reference to the Bristol anti-friction roller valves. This style of valve was put on four engines when completed in 1868 and have been continued to the present date. When put up in good shape and properly adjusted they work very satisfactorily for probably about an average of fifteen months, they then will require repairs, the rollers and strips upon which the rollers travel become worn, and all have to be repaired and adjusted. All things considered, I consider the Richardson balanced device the best that we have tested or have any knowledge of at the present time."

To the question, "What is the cost of these balanced valves and necessary adjuncts per engine, compared with the ordinary valve," the following answers were received:

Mr. J. Davis Barnett states that if standard sizes are adopted throughout and milling tools used on the work, the total extra cost per valve will not exceed five dollars.

Mr. Allen Cooke states that the first cost of equipping an engine with the Richardson balanced valve is about as much again as with the common valve.

Mr. Harrison states that it costs twelve dollars per engine to apply the Beckert attachment to the old style of valve. With the Richardson valve he is compelled to make new yokes and have the balance plate under steam chest cover. With the Beckert valve nothing is required but to plane off inside face of cover and top of old valve.

Mr. Meehan, through Division Master Mechanic Tomlinson,

states that the cost of each of the three valves used on his road is about double that of the ordinary D valve. The Margach probably being the most expensive and the Richardson the cheapest, royalty being equal.

Division Master Mechanic Fowle agrees with Mr. Tomlinson as regards the relative price of balanced and ordinary D valves.

Mr. C. E. Smart states that the Richardson balanced valves and necessary adjuncts cost nearly four times as much as the ordinary slide valves.

Mr. Thomas B. Twombly states that the cost of the balanced valves, as used by him, over that of the ordinary valve is about eighteen dollars per engine.

Mr. William Woodcock reports the cost of balanced valves per engine to be ninety dollars, and that of ordinary valves ten dollars.

To the question "What is the average cost per engine per annum of maintaining these balanced valves and their seats; give figures applicable to each 12 months after valves were placed in service until their renewal was required; give similar figures in the case of ordinary valves on the same class of engine, and, if possible, mileage made each year," the following answers were received:

Mr. Barnett states that the cost is variable; that he has run for two years without breaking steam-chest joint and at other times springs have had to be renewed within a month or two. He estimates the average cost of maintenance to be not more than three dollars per valve.

Mr. Allen Cook reports the cost of repairs for two years and eleven months in the case of engine 42, fitted with Richardson valve, $4.50, and which was for one facing the seats; he states, that with the ordinary valve, seats require to be faced every 5 to 7 months.

Mr. Harrison states that none of the Richardson or Beckert valves have been running a year, but up to the time of his report the cost of maintaining the Beckert valve had been comparatively nothing. The Richardson valves had seats of left cylinder faced off three times since it was put in, and had end balance strips broken in two once.

Mr. Meehan, through Division Master Mechanic I. W. Fowle, reports that the average cost per engine of maintaining the balanced

valves the first twelve months after they were placed in service was one dollar. He has no engines of the same class equipped with ordinary valves and is unable to give cost of their maintenance.

Mr. Geo. W. Stevens states that from observation it is quite evident that the cost of maintaining the Richardson valve will not exceed that of the plain valve.

Mr. Twombly reports the average cost of maintaining the valves as used on his road to be eight dollars per annum; that of the ordinary valve, ten dollars.

Mr. Woodcock reports cost of facing seats and valves at five dollars.

To question six, "What mileage is represented by one-fourth inch wear of valve seats of similar engines, when using and when not using the balanced valve, and state if vacuum valves were used in each case on steam chests," the following information was received:

Mr. Allen Cooke reports placing Richardson balanced valves on engine No. 42, a Mogul with 18 by 24 inch cylinders, on January 29, 1883. On August 11, 1884, after running 50,922 miles with freight trains, and hauling 42 loaded cars in summer and 35 in winter, the valve seats were faced, the wear having been one sixty-fourth of an inch; the engine then ran until the 31st of December, 1885, making 44,925 miles additional, when she was shopped on account of accident, but required no work to valves or seats, neither to links, pins, or valve gear, as there was no lost motion to be taken up.

Mr. Meehan's Division Master Mechanic, Mr. Fowle, states that during the 15 months his Mogul engines have been in service with the DeLancy valves he has not had occasion to face a single valve, and they are all now in first-class condition, and not one of them will show one thirty-second of an inch wear.

Mr. Woodcock has supplied the following tabular statement, showing in the case of 10 passenger engines engaged in high speed service and equipped with Richardson Allen valves, that one thirty-second of an inch wear of the valve seats was the result of an average mileage of 41,663 miles, and ranging from 24,811 to 65,542 miles:

STATEMENT SHOWING WEAR AND SERVICE OF ALLEN VALVE WITH RICHARDSON'S BALANCING DEVICE AS USED BY CENTRAL RAILROAD OF NEW JERSEY.

ENG. NO.	DIMENSIONS OF CYLINDERS.	VALVE PUT IN.	VALVE SEATS FACED.	WEAR.	MILEAGE TO $\frac{1}{32}$″ WEAR.	TOTAL MILEAGE.	REMARKS.
162	19″x 24″	Oct. 3, 1882.	9-25-84 and 12-25-85.	$\frac{1}{16}$″	28.925	57,850	
163	19″x 24″	Apr. 30, 1883.	6-25-85.	$\frac{1}{32}$″	44,616	44.616	THESE
164	17″x 24″	Jan. 10. 1885.	9-14-85.	$\frac{1}{32}$″	32,075	32,075	
165	17″x 24″	July 24, 1882.	4-26-83. 10-23-83, and 7-17-85.	$\frac{3}{32}$″	40,372	121,116	ENGINES
168	18″x 24″	Nov. 22, 1882.	2-15-84 and 12-10-85.	$\frac{1}{16}$″	46,220	92,441	ARE ALL IN
169	18″x 24″	Feb. 24, 1882.	4- 5-82 and 4- 7-85.	$\frac{1}{16}$″	65 542	131,085	
172	18″x 24″	Mar. 5, 1883.	10- 2-85 and 2-26-86.	$\frac{1}{16}$″	54.146	108,292	PASSENGER
173	18″x 24″	Apr. 14, 1883.	10- 3-83, 12-29-85, and 1-18-86.	$\frac{3}{32}$″	24,811	74,433	SERVICE
174	17″x 24″	Dec. 19, 1882.	9-26-83, 4- 1-84, 9- 8-84 and 9-28-85.	$\frac{1}{8}$″	30,555	122 220	HIGH SPEED.
175	17″x 24″	Feb. 7, 1883.	2-12-84.	$\frac{1}{32}$″	49.375	49,375	

AVERAGE MILEAGE TO $\frac{1}{32}$″ WEAR OF VALVE SEATS, 41,663.

ELIZABETH, NEW JERSEY, May 5, 1886.

[Signed] WM. WOODCOCK, *M. M.*

He states that before the application of balanced valves to this class of engine it was generally found necessary to face the valve and seat after running an average of 6,000 miles, with a wear of

from one-thirty-second to one-sixteenth of an inch. He thus increased the life of valves and seats by the use of balanced valves from 700 to 1400 per cent., at the same time saved the cost of facing them and kept the engines in continuous service, so far as the valves and seats were concerned.

To questions Nos. 7 and 8, "When packing strips are used what width should they be to give best results; should they and the grooves in valves be fitted by scraping, or will planer and milling machine make a sufficiently good finish?" when springs for holding up the packing strips are used what kind give best results, the following answers were received:

Mr. J. Barnett states that grooves in valves could not be cut by planer, as the work is not satisfactorily or dead true, but if finished by two cutters with three working faces on milling machine, no hand work is required. He uses coiled steel springs two and one-sixteenth inches long, five-eighths inch outside diameter, of No. 15, B. W. G. round steel, coiled to five-thirty-seconds of an inch pitch, which proved satisfactory.

Mr. Allen Cooke uses packing strips nine-sixteenths of an inch thick and flat steel springs he fits by scraping, but thinks that a perfect milling job would do very well.

Mr. Harrison is of opinion that seven-sixteenth of an inch packing strips give the best results and considers spiral springs to be preferable. He states that the rings used in the Beckert valves do not require any scraping, but merely turned up to fit inside, allowing one-sixteenth of an inch outside for steam.

Mr. Meehan, through Division Master Mechanic Tomlinson, states that he considers packing strips should be from three-fourths to seven-eighths inch deep, by one-half inch to five-eighths inch wide. He considers scraping unnecessary and prefers half elliptic springs one-sixteenth of an inch narrower than the strip and one-sixteenth inch in thickness, if well tempered, for keeping the strips up to their work.

Mr. Fowle states that packing strips three-fourths of an inch square give the best results. The strips and grooves need not be scraped; the planer and milling machine will make a sufficiently good finish. Elliptic springs made of five-eighths by one-sixteenth spring steel give better results than any other kind he has tried.

Mr. Smart considers that half an inch in thickness is sufficient to give good results and that planing or milling if perfectly done will make a sufficiently good finish. He prefers half elliptic springs for the purpose of holding strips up against steam chest cover.

Mr. W. H. Stearns says that he thinks planer and milling machine will answer, and that he uses flat steel springs for holding up the packing strips.

Mr. Twombly states that the strips used on his valves are nine-sixteenths of an inch wide; the sides of strips and grooves in valves are not scraped, but the strips are fitted to the inside of steam chest cover by scraping, both strips and cover being finished in this manner. He uses flat steel springs of semi-elliptic form.

Mr. Woodcock prefers close machine fits to scraping, and uses flat steel springs for holding up the strips.

To question No. 9, "What increased life of valve gear is attained by using balanced valves; does it thereby reduce the cost of engine repairs to an appreciable extent?" the following answers were received:

Mr. John Aspinall, Locomotive Superintendent of the Great Southern & Western Railway of Ireland, states that he has recently been carefully investigating the question of the friction of locomotive slide valves, but having sent the manuscript containing the result of his observations to the Institution of Civil Engineers in London he is not at liberty to make use of the information until it has been published by them. He states, however, that he has found the friction to be somewhat less than is generally supposed, so as to make it very doubtful as to there being any economy in using balanced valves.

Mr. Barnett answers in the affirmative but has no records whereby he can give more definite answer.

Mr. Allen Cook states, "It is a great paying investment in regard to valves motion, easy working of engine and saving in fuel."

Mr. Drummond, of the Caledonian Railway, states that the present manager of the Saint Rollox works had charge of the experiment with Allen valve and informs him there was no saving by their use, either in fuel or in tear and wear of valve gearing, and were consequently gradually given up.

Mr. Harrison considers the life of the valve gearing to be increased about 75 per cent. by using balanced valves, and the cost of repairs to engines is reduced considerably.

Mr. Jacob Johann, Master Mechanic of the Chicago & Atlantic Railway, states his experience with the modern style of balanced slide valve to be very limited, but he is well satisfied that a well constructed balanced valve to be a decided advantage in the operation of a steam engine.

Mr. Meehan, through Mr. Tomlinson, states that the saving by the use of balanced valves appears most in the increased life of pins throughout the link motion, as also in the blocks and eccentrics, and this he places at a saving of 50 per cent.

Mr. Fowle places the saving in life of valve gear by the use of balanced valves at 100 per cent. He states that during the 15 months that his Moguls have been in service he has not had occasion to face a single valve, and they are all now in first-class condition, not one of them showing one thirty-second of an inch wear.

Mr. E. M. Roberts, Master Mechanic, Ashland Coal and Iron Railway Company, reports that a piston balanced valve, as shown in drawing here exhibited, and fitted to one of his engines, has proved an unqualified success, being a perfect balance and so reduces the friction, that reverse lever can be moved with throttle wide open as readily as when steam is shut off. [See Plate 30.]

Mr. Smart states that the length of service would not justify him in giving a decided answer, but is of opinion that it will increase immensely the life of valve gear.

Mr Stirling, of the Great Northern Railway, states that he tried three kinds of balanced valves without success; in each case the consumption of fuel was greatly increased by the inevitable leakage even when they were quite new and in the very best condition. He has not thought of balancing for years, and has not a single set of balanced valves at work.

Mr. Stroudley, of the London, Brighton, & South Coast Railway, states that he paid particular attention to the quantity of oil used by engines fitted with the Adams valve as compared with those working with the ordinary slide valve, and found that the

quantity used with the balanced valves was considerably greater, also that it made no appreciable difference in the consumption of coal. "You could, however," he states, "when the engine was working at 140 lbs. pressure, regulator wide open, hold the lever in one hand when standing square across. In fact, you could reverse the engine into back gear to and fro with one hand quite easily, almost as readily as though the steam were shut off."

Mr. Twombly states that increased life of valve gear equal to nearly 100 per cent. is obtained by his company in using balanced valves, and their use *does* reduce the cost of repairs to an appreciable extent. As an instance, Mr. Twombly states that one of the first engines on which these valves were placed, No. 243, has been running on heavy passenger service for six years and not a pin in her link motion has been replaced. This would be impossible with unbalanced valves.

Mr. Woodcock answers this question in the affirmative, but has not data to offer.

Mr. Jones, of the Highland Railway, has furnished your committee with tracing here exhibited, showing the standard valve used on that road. In explanation he states that the holes are not filled with any kind of metal and apparently are intended for the purpose of reducing the pressure between valve and seat. He states that his engines with these valves work up and down grades of one in 70 and 15 miles in length, the daily run being 144 miles with express trains, in 4 hours, stopping seven times during the journey, and climbing one thousand five hundred feet, valves being made of cast iron.

Mr. Stroudley states that on the London, Brighton & South Coast Railway, he has about 410 engines with the ordinary valves, and they are usually faced up every six to twelve months. He says "We face them by hand and pay 20 shillings per engine for doing it. We use in some engines cast iron valves, in others ordinary, hard brass, and in some phosphor bronze. Where the cast iron valves happen to suit the metal of the cylinder they appear to work the best of any. Next in order comes phosphor bronze. It appears to work beautifully under any circumstances. Those of ordinary brass having about two-thirds of the life of a phosphor bronze

valve." He also states that on the Highland Railway which has long inclines, engines run as many as 15 or 20 miles at a stretch without steam; he is of opinion that in such circumstances a balanced valve that will not fall away from the face will not work satisfactorily, and the saving to be gained by balancing will not, in his opinion, pay for the complication necessary to effect it.

Mr. Woodcock reports that previous to the application of the Richardson valve, and when using plain valves he usually found it necessary to face valve and seat after running an average mileage of 6,000 miles, with a wear of one thirty-second to one-sixteenth of an inch. At this rate the seats would have soon been worn out. It therefore became a serious matter and necessary to provide a remedy to prevent this incessant wear of the seats, and after a test of one set of the balanced valves he was satisfied that he had overcome the difficulty. He believes that this was the first Allen valve balanced with the Richardson balancing device, and was placed on engine No. 169.

The valves most favorably reported on appear to be the Richardson, the DeLancy, the Morse, as used by Mr. Twombly, the Adams, as used by Mr. Manson on the Great North of Scotland Railway, also the Beckert valve, as used by Mr. Harrison on the Baltimore and Ohio Railroad. The latter, although well spoken of, has been so short a time in the service,—about one year only,—that it is impossible to say how it will eventually compare with its competitors.

Attention of your committee has been called to the Reaser, the Dathie, the Ferguson, and the McDermott valves, [see Plate 31] but no official report of their trial on locomotives has been received. The drawings are here exhibited and can be examined at your leisure. The information furnished is, we consider, sufficient to warrant your committee reporting favorably on the results obtained with several makes of balanced slide valves and above referred to. They are especially of service on engines with steam ports necessitating slide valves of large dimensions; the consequent reduction of friction due to the load being removed from the slide valves, results in very much increased life of the valve seats, valves, pins, blocks, and all other connections of the link

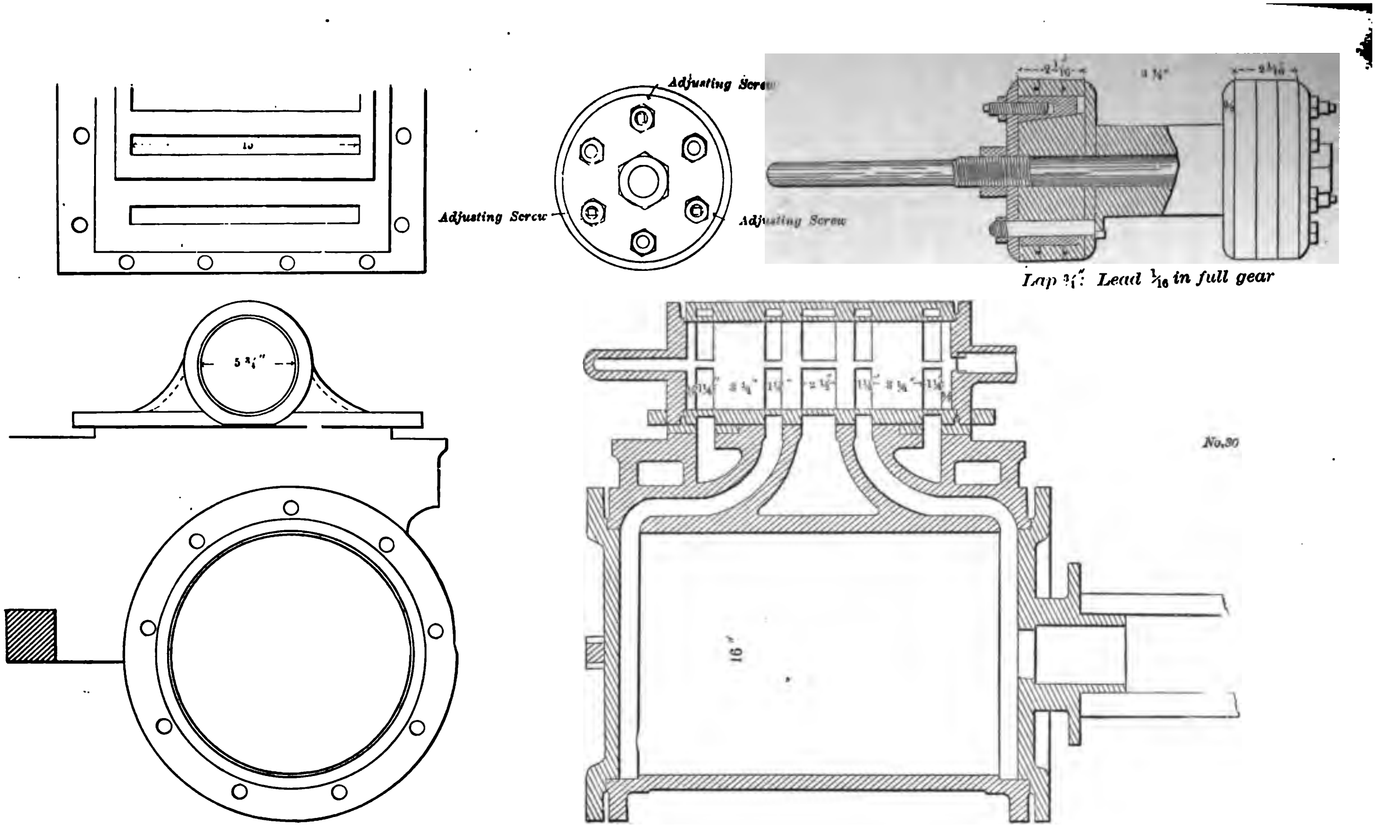

Adjusting Screw
Adjusting Screw
Adjusting Screw
5 ¾"
16"
No.30
Lap ¾" Lead 1/16 in full gear

Plate 30.

motion, as notably described by Messrs. Twombly and Woodcock. By their use engine men are enabled with ease to regulate the distribution of steam in the cylinders by means of the reverse lever, without shutting off, a matter of no little importance in the case of heavy trains on long, steep and continuous grades. Your committee suggest the desirability in future of keeping account of the mileage made, wear of the seats, etc., as done by Mr. Woodcock. This will enable comparisons to be made, and will prove of much interest to the Association when the subject is next brought to the front. The diameter of driving-wheels should also be noted.

This opportunity is taken to thank members of the Association, and to place on record that due to British Locomotive Superintendents for the information furnished your committee for this report, the whole of which is respectfully submitted:

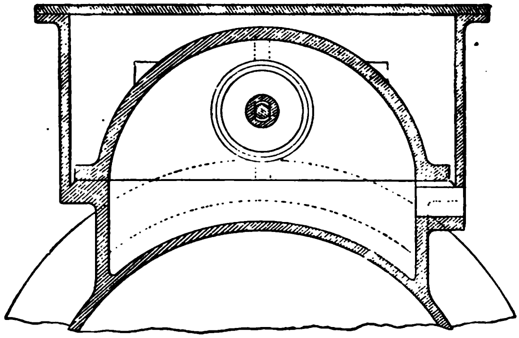
CHARLES BLACKWELL,
JAMES MEEHAN,
E. M. ROBERTS,
Committee.

SUPPLEMENTARY REPORT ON BALANCED SLIDE VALVES.

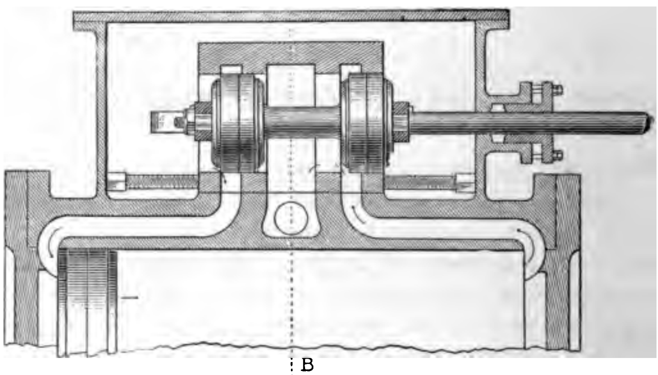
Since our convention recently held in Boston, the Committee on Balanced Slide Valves has received the following information from Mr. W. Adams, Locomotive Superintendent of the London and South-Western Railway, of England. He states: "We have tried Church's patent balanced circular slide valves on a few of our engines, and so far as the principal of balancing the pressure, these valves have fulfilled the conditions. They are, however, subject to the defect of tilting, due to the change of the relative positions of the valve, and the raised table used for effecting the equilibrium of pressure. As we found it impossible to cure this defect, we have decided to return to the usual form of slide valve."

CHARLES BLACKWELL,
Chairman of Committee on Balanced Slide Valves.

June 29, 1886.



Vertical Section on Line A. B.



Longitudinal Vertical Section of Valve.

Plate 32.

FERGUSON'S PATENT BALANCE VALVE.

THE PRESIDENT—The paper is now open for remarks. Mr. Meehan, will you open the discussion ?

JAMES MEEHAN—I think that the De Lancy valve gives us better satisfaction than any we have ever used; but I believe I said all I have to say to the Committee. I think, perhaps, Mr. Blackwell can give us more information on that subject than any one else. All I can say is as to the necessity of the valve. I think it is one of the growing necessities of the times.

CHARLES BLACKWELL—It seems to me that Mr. Woodcock ought to be able to give us valuable information about this. It appears by his report that he has effected economy amounting to from 700 to 1400 per cent. That seems almost incredible.

W. WOODCOCK—I think Mr. Blackwell misunderstood me. We used the Allen valve on the balance, and I said I thought that the Allen valve put into our engine No. 169 was the first Allen valve balanced with the Richardson device, and that is what makes the great difference in the wear from using the common slide valve. We faced those seats after running six to eight weeks, and the matter became evident to my mind that we would have soon to renew the cylinders or seats. I had some correspondence with Mr. Richardson, and he agreed to balance one of the Allen valves for a trial, and it worked very satisfactorily, and those valves have run twelve to eighteen months without facing. That is where the difference came in. These valves were in service on high speed passenger engines. The service was severe, and it became a serious matter with us in reference to getting a valve that would run some length of time, and save taking the engine out of service. I can only say, as noticed in the report, that the valves are working very satisfactorily, and I should be inclined to place more of them in service.

On motion of Mr. E. A. Campbell the discussion on this report was closed.

THE PRESIDENT—I think it would be in order at this stage of the proceedings to appoint a Committee on Resolution. I would, therefore, appoint Mr. Angus Sinclair, Mr. M. N. Forney and Mr. Allen Cook as that committee.

J. N. LAUDER—I would like with unanimous consent to make a statement. The Boston & Hingham Steamboat Company, which run from Boston to Mantasket Beach, wishes to tender to the Association, as a body, or individually, an invitation to ride at will on their steamers during the session of this convention. The only credentials needed will be the Association badges.

THE PRESIDENT—The subject will be referred to the Committee on Resolutions.

E. A. CAMPBELL—When we accept the report of the Committee on Balanced Slide Valves, what do we do with the committee?

J. N. LAUDER—For the information of the gentleman I will say that the usual method is to receive the report, and with that it is understood that the committee is discharged.

THE PRESIDENT—There being no report from the Committee on "Best Material and Form of Construction for Locomotive Guides and Cross-heads," what action will the Association take?

JOHN BLACK—I move that the Committee be discharged.

J. N. LAUDER—Wouldn't it be better to refer the matter to the Committee on Subjects? I think it is a little too arbitrary to discharge the Committee without knowing why they have not made a report.

JOHN BLACK—I will withdraw the motion.

J. N. LAUDER—Then I move that it be referred to the Committee on Subjects.

ANGUS SINCLAIR—I second the motion.

Carried.

THE PRESIDENT—The report from the Committee on "Best Plan of Removing, Cleaning, and Resetting Flues," is now in order.

[The report was read, and, on motion, accepted.

REPORT OF COMMITTEE ON THE BEST PLAN OF REMOVING, CLEANING AND RESETTING FLUES.

Your committee to whom was referred the subject of "The best plan of removing, cleaning, and resetting flues," would report that they issued the following circular of enquiry to all members of the Association.

OMAHA, April 28th, 1886.

To the Members of the American Railway Master Mechanics' Association:

GENTLEMEN:—The undersigned have been appointed as a committee to ascertain the best plan of removing, cleaning and re-setting flues, and respectfully solicit answers to the following questions:

First. What, in your opinion, is the best method of removing flues? Please describe in detail.

Second. Have you ever removed flues by the aid of a locomotive or other power? If so, please give experience.

Third. Does the manner in which flues are set affect the plan of removal? If so, how?

Fourth. What do you consider the most economical and thorough way of cleaning flues after they have been removed from boiler?

Fifth. What have you found to be the best manner of resetting flues?

Sixth. What material do you consider the best for flue ends?

Seventh. Have you found it more satisfactory to weld or to braze ends to flues?

Eighth. Does the character of the water or fuel used in any way govern the manner of doing above work? If so, please state in what particular.

As far as possible, please send with your report, drawings or sketches giving dimensions of all special tools or devices.

That the Committee may be enabled to make as complete a report as possible, and one analyzing the subject under all conditions, they would request members not to confine their reports to direct replies to questions, but give all information obtainable.

Please send reports at as early a date as convenient, to Clem. Hackney, Supt. M. & R. S., U. P. Railway, Omaha, Neb.

CLEM. HACKNEY,
A. W. SULLIVAN,
G. H. PRESCOTT.

We have received answers, all more or less complete, from twelve members, as follows:

Question No. 1. What, in your opinion, is the best method of removing flues? Please describe in detail.

Answer. Four cut-off flues inside of front flue sheet.

Two members say they split forward end of flue about 1 inch inside sheet. One member reports that if flues are not badly scaled, his practice is to turn down the bead in fire-box end and drive them out. If scale has formed on them to such an extent as to prevent their removal readily, take out the dry pipe, cut off flue end inside of fire-box flue sheet, turn down bead on front end, and

drive flues into the boiler. Five do not give particulars. Of the whole number, three report using a hook cutter, and two report using a cutter bar to cut off flue ends. Others do not use special tools. Eleven say they take flues out through dry pipe opening, when all are to be taken out, but use one of the tube holes in front flue sheet, enlarged for the purpose, where only a few (thirty or forty) flues are to be removed. One member always takes the flues out through an enlarged hole near bottom of front flue sheet.

Question No. 2. Have you ever removed flues by aid of a locomotive or other power? If so, please give experience.

Answer. Mr. Allen Cooke, of the Eastern Ill. Ry., says he has removed flues with a locomotive but does not think it pays.

Mr. Wm. Swanston, of the C., St. L. & P. Ry., has tried to draw flues through the front flue sheet, but without success.

Mr. Jacob Johann, of the Chicago & Atlantic Ry., has used an engine to pull out a few flues, but gave it up for the reason that it strained the flue sheet, and ground the holes out of round. A better way, he thinks, when only a few bottom flues are to be taken out, is to ream out one hole, about one-eighth of an inch, and draw the flues, with a windlass of two-inch round bar iron, to extend across front end, and to rest on two of the front end studs; in each end of this bar should be a one-inch hole for ⅞ inch lever, in center of bar to be an eye bolt, with chain attached, to use, cut bead, etc. off both ends of flue, and drive it out 6 inches, attach chain, and draw flues out with windlass.

Mr. Wm. Montgomery, of the P. & R. Ry., says he never used a locomotive for this purpose, but has witnessed the experiment, and considers it very dangerous, on account of liability to break the bridges between holes in flue sheet.

One other member reports using a windlass, but does not describe it.

Question No. 3. Does the manner in which flues are set affect your plan of removal? If so, how?

Answer. Nine members report that the manner in which flues are set does not affect their plan of removal.

Mr. Wm. Montgomery, of the P. &. R. Ry., says that putting copper ferrules on fire-box end gives some trouble in drawing flues

through front flue sheet; he sets the flues in back end with a tool which enlarges the flue and ferrule inside the sheet.

Mr. Jacob Johann says that in using the "Prosser Expander," the piece left after cutting off the end is a trifle harder to get out of the way.

Mr. R. C. Blackwall, of the D. & H. Canal, reports that flues set with the "Prosser expander" are more difficult to remove than those set with the "Roller Expander," on account of shoulder being formed on inside of sheet.

Question No. 4. What do you consider the most economical and thorough way of cleaning flues after they have been removed from the boiler?

Answer. Ten members report the tumbling barrel as the best means of cleaning flues.

Mr. Wm. Swanston, of the C., St. L. & P. Ry., reports that for the past 18 months he has been using an Otto flue cleaner manufactured by the Flanders Machine Co., and regards it as the best appliance for the purpose he has seen.

One member scrapes his flues, but has had no experience with any other method.

Mr. T. J. Hatswell, of the F. & P. M. Ry., tumbles his flues in water.

Mr. J. S. Graham, of the L. S. & M. S. Ry., in speaking of tumbler used by that Company says: Tumbler is made of an old boiler, lengthened to suit, and is run at a speed of 30 revolutions per minute; can clean 45 to 50 flues at a time, in one to two hours. Thinks this form of tumbler especially good, as the rivet heads, on inside of sheet, find the poor flues, by indenting or breaking through the thin spots.

Mr. Jacob Johann thinks a few hard clinkers should be put in with the flues, and the tumbler speeded just fast enough to carry the flues to the top center, letting them drop before they pass that point, thinks that the drop does the work much more efficiently than the mere rolling of the flues over each other.

Question No. 5. What have you found to be the best manner of resetting flues?

In resetting flues, hardly any two of the members do the work exactly alike, and we give method employed by each.

Answer. Mr. R. C. Blackwall says that their practice is to anneal both ends of tube, drive on swedge to take off bur, and compress ends for copper liner, expand with Prosser tool, bead and calk, then finish lightly with Dudgeon Roller.

Mr. W. Woodcock, of the N. J. C. Div. P. & R. Ry., uses the Prosser expander, and thinks it the best because flues are set out between sheets and form a stay; uses the Dudgeon roller to set flue out to fit sheet, also uses the latter tool for repairs.

Mr. Allen Cook says, drill hole for 2 inch flue $2\frac{1}{16}$ inches, use copper ferrule to bring diameter of hole down to $1\frac{29}{32}$ inches, secure ferrule in hole with Prosser expander, swedge flue ends taper for driving fit, expand hot with mandrel to fit flue holes in front end; as fast as flues are driven home, expand with Prosser expander enough to hold in place until all are in, then use expander hard enough to set flue out tight, and form collar inside, so that sheet is held between collar and bead; lap flue with ball hammer, and bead with heel tool, being careful to always work outwards, working flue over copper, and make small bead; use Dudgeon's expander lightly to finish with. Thinks it pays to bead front ends, as flues make a better brace for sheets, by doing so.

Mr. T. J. Hatswell uses copper ferrule on fire-box end; uses Dudgeon expander, and beads flue over the copper; gives no particulars as to front end.

Mr. C. W. Mills, of the R. & P. Ry., says, "set flues and roll with Dudgeon expander." No particulars.

Mr. John Player, of the C. I. Ry., reports that the best manner that they have found, is to use the copper ferrule, and roll or expand with the Dudgeon expander.

Mr. Jacob Johann says he prefers to have the flue holes in back flue sheet a trifle less in diameter than flues, and after grinding the rust off the end of flues, with an emery wheel to drive them into place, flue holes in front sheet to be two and one-sixteenth inches in diameter for two inch flues, to allow for light copper ferrule. He says, however, that many of the engines now on that road have flue holes in back sheet $\frac{3}{4}$ inches in diameter, this necessitates

swedging down the back ends of the flues and the holes are so badly out of round that copper ferrules have to be used, in order to make a joint.

Mr. J. S. Graham knows of no better method than rolling front end, and rolling and beading back end; he uses a roller turned to the same taper as the spindle, but reversed, so that the large ends of the rollers shall come on the inside of sheet, when used, insuring a joint at that point first.

Mr. Wm. Swanston says the best plan they have tried for doing this work is to bore the holes in flue sheet $\frac{1}{32}$ inch larger in diameter than the flue, swedge or die, the fire-box end of flue down $\frac{1}{32}$ inch and braze on a copper ring, this to be filed off to a driving fit in sheet; on the front end the scale is removed from flue, and a light copper ring inserted (but not brazed), between sheet and flue; use the roller expander, and bead fire box end; do not consider it necessary to bead front end.

Mr. Wm. Montgomery reports that they have found the best manner of setting flues to be as follows: Swedge down fire box end one-sixteenth inch, file the end off bright, and put on a copper thimble, to bring flue up to size, set with Dudgeon expander, then use tool to form a groove, or enlargement of flue just inside sheet, making a joint next the water; bead flue on outside of sheet. This makes a firm job, and one not likely to be loosened by the expansion of the flues.

Mr. Geo. Hackney, of the A. T. & S. F. Ry., uses copper bushings expanded to fit holes in flue sheet, end of flue to be ground smooth on emery wheel, placed in a position, and expanded with roller, only fire-box end beaded.

Mr. G. W. Stevens, of the L. S. & M. S. Ry., expands with roller and flanges with thumb tool.

Question No. 6. What material do you consider the best for flue ends?

Answer. Nine members say that they consider good soft iron the best material for flue ends.

Two use semi-steel.

Mr. T. J. Hatswell says, use ends of the same material as the body of flues.

Mr. Montgomery says, that he thinks that it will pay to put ends of good charcoal iron, on new flues.

Mr. W. Swanston reports having tried flue ends of steel and semi-steel, but without much success.

Question No. 7. Have you found it more satisfactory to weld or to braze ends to flues?

Answer. Eleven members report in favor of welding ends to flues

Mr. Jacob Johann says either welding or brazing can be made satisfactory, and he thinks there is little difference between the two methods: says he knows, from actual experience, that when fitted up, with special tools for cutting off, scarfing, and brazing, that the brazing can be done much cheaper than welding, and always insures a straight flue; in brazing much cheaper labor can be employed than in welding. The first cost of fitting up for brazing, would be greater than for welding, but thinks that the difference in cost of doing the work, would more than offset this, more flues can be brazed than welded per day, with a given number of men. A description of special tools used by him for brazing, is now in possession of your Association.

Mr. W. Swanston says, we only resort to brazing when flues are of so poor a quality as to give trouble in welding.

Question No. 8. Does the character of the water or fuel used, in any way govern the manner of doing the above work? If so, please state in what particulars.

Answer. Eight members report that neither water nor fuel materially affect the manner of setting flues.

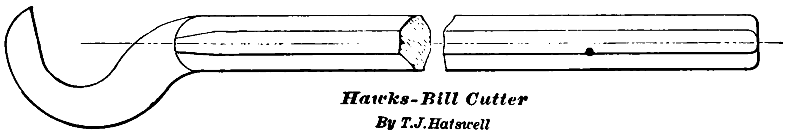
Mr. Wm. Swanston thinks, with good soft water, it would not be necessary to use copper rings, and that as good results would be obtained by setting flues iron to iron, but with water of that section, copper is a decided improvement.

Mr. Jacob Johann thinks that flues tight with one kind of water and fuel, will be tight with another, but thinks that they may make a decided difference in the length of time flues remain tight; says the softer and freer from sediment the water is, and the more free from sulphur the coal is, the longer the flues will last; thinks also that the length of time that the flues will last depends materially on the engineer.

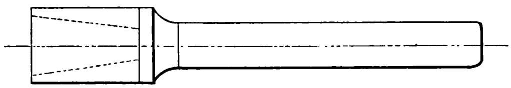
Mr. Montgomery says that they use the same engines for both hard and soft coal, and he does not see any especial difference, but that the beads on bottom flues burn off faster with hard than with soft coal. Uses in some cases cast iron ferrules which he thinks are an advantage; does not think that the quality of water affects the method of setting.

Mr. W. Woodcock uses a "Saddlers" patent flue welding machine. The weld is made by revolving rolls and is a very simple and effective machine.

Mr. Allen Cook sends sketch of crimping tool which find attached.



Hawks-Bill Cutter
By T.J. Hatswell



Flue Crimping Tool
By Allen Cooke

Plate O.

Mr. T. J. Hatswell sends blue print of Hawks Bill for cutting off flues, which please find attached, he also gives price of taking out welding, and resetting one flue by hand, at 17 cents.

From the reports furnished, and from our own experience, we have reached the following conclusions:

First. The best known method of removing flues is to use a cutter bar, to cut off flues inside of front flue sheet, and turn down bead on back end; when all flues are to be taken out, take out dry pipe and take flues out through dry pipe opening; when only a few flues are to be removed, use one of the tube holes in front flue sheet, enlarged for the purpose.

Second. Taking all of the circumstances of the case into consideration, do not consider it advantageous or economical to use locomotive or windlass to remove flues.

Third. The manner in which flues are set, does somewhat affect the plan of removal, but in consideration of the great importance of having flues set to give the most efficient service in practice, do not think the difference enough to be considered a factor.

Fourth. Consider the tumbling barrel as the best known means of cleaning flues.

Fifth. Know of no better method than rolling front end and rolling and beading back end, use copper ferrule expanded to fit holes in flue. Flue to be placed in position and expanded with roller; do not consider it necessary to bead front end.

Sixth. Consider good soft iron the best for flue ends.

Seventh. Have had no trouble from either brazed or welded flues, with proper flue welder, have every reason to believe welding is cheaper.

Eighth. Would recommend manner of setting as explained above for all kinds of water or fuel.

Your Committee have not received or prepared drawings of Flue Welders or other special tools, but feel assured it would prove of great advantage to have such gotten up, and that the above subject deserves further investigation by the members of this Association.

Respectfully,

CLEM. HACKNEY,

Chairman.

THE PRESIDENT—The paper is now open for discussion.

C. HACKNEY—I would like to hear Mr. Johann explain what reason he can give for thinking that brazing is cheaper than welding.

JACOB JOHANN—I didn't think I would be called upon to talk upon this matter, or I would have come prepared with the figures. Five or six years ago when I was in charge of the Wabash establishment, at our Springfield shops we brazed, and at our other shops we welded. At each of the shops they have special machinery for doing that kind of work. I instructed the master mechanics in charge of those shops to make a special trial to see what the comparative cost was as to brazing and welding, and to that end I wanted them to take three hundred flues and commence at that point, which was done at each shop about the same time. They welded and brazed, and I am not quite positive, but I think, the manipulation of the three hundred flues for welding at each of the shops cost between $24 and $28 all told. The brazing cost be-

tween sixteen and seventeen dollars. I can get the abstract of those tests and furnish them, so that Mr. Hackney can embody them in the report if he desires. That is the only reason I can give why brazing is cheaper than welding.

C. HACKNEY—A great many of the members who were corresponding with me on the subject wished me to obtain the figures if possible, as there seems to be a decided difference of opinion among members of our Association all over the country.

JACOB JOHANN—I will furnish them to you on my return home.

The following is the information asked for:

Cost of cleaning, piecing, etc. 300 *2-inch iron boiler tubes, and getting them in complete order to go back into engine.*

WABASH, ST. LOUIS & PACIFIC RAILWAY.

EASTERN DIVISION, FORT WAYNE SHOPS.

Cleaning and cutting flues and pieces, 45 hrs. @ 16c.		$7.20
Scarfing flues and pieces 40 hrs. @ 20c.		8.00
" " " " 40 hrs. @ 16½c.		6.60
Welding and swedging, 15 hrs. @ 20c.		3 00
" " " 15 hrs. @ 16½c.		2.47
Total labor,		27.27
Coke, 4 bu. @ 15c.	.52	
Coal, 2 bu. @ 18c.	.36	88
Total cost of 300 flues		$28.15

MIDDLE DIVISION, SPRINGFIELD SHOPS.

Attending rattler, 6 hrs. @ 14c.	.84
Cutting ends of flues, 23 hrs. @ 7½c.	1.72½
Scarfing out pieces, 31 hrs. @ 7½c.	2.32½
" ends of flues, 30 hrs. @ 7½c.	2.25
Fitting pieces on flues, 20 hrs. @ 16c.	3.20
Brazing ends on flues, 20 hrs. @ 16c.	3.20
Chipping, swedging, and testing, 30 hrs. @ 16c	4.80
Cutting to lengths, 20 hrs. @ 7½c	1.50
Total labor	19.84

Charcoal, 6 bu. @ 10c.	.60	
Brazing wire, 3 lb. @ 28c.	.84	
Spelter, 2 lb. @ 26c.	.52	1.96
Total cost of 300 flues		$21.80

WESTERN DIVISION, MOBERLY SHOPS.

Blacksmith, 65 hrs. @ 22½c.		14.62
" helper, 65 hrs. @ 16c.		10.40
Total labor		25.02
Coke, 4 bu. @ 13c.	52	
Coal, 2 bu. @ 18c.	36	88
Total cost of 300 flues		$25.90

COMPARISON, TOTAL COST.

Eastern Division,	"Weld,"	$28.15
Middle "	"Braze,"	21.80
Western "	"Weld,"	25.90

COST PER FLUE IN CENTS.

Eastern Division	9.28 cts.
Middle "	7.27 "
Western "	8.63 "

CHARLES BLACKWELL—It appears to me from what I heard of the report of the Committee on this subject that information has not reached them of the use of the cutter used on the inside of the flue for removing it, acting the same way as a cutter only reversed, the steel cutters being on the inside of the pipe instead of on the outside. Before I left the Norfolk and Western Railroad one of my foreman got up a machine for effecting this purpose, and it worked splendidly. It saved placing the tube afterwards in a lathe for cutting the ends off. They were already perfectly smooth on the end. If any members have seen this little machine work, they no doubt will endorse my statement. I do not know whether the machine is patented or not, but it was invented by a man named W. C. Rolston. It was a hand tool, and made to be automatic. It was inserted in the tube opening. The handle was revolved and after a certain number of revolutions the tube was cut. I forget the number of cutters that there were, but anybody can find out all about it by corresponding with Mr. Rolston. It is a machine for taking out a tube in a scientific and mechanical manner.

SECRETARY SETCHEL—I suggest that Mr. Blackwell give the gentleman's address clearly to the Convention.

CHARLES BLACKWELL—Mr. W. C. Rolston, master mechanic of the Shenandoah Valley Railroad, Roanoke, Virginia.

SECRETARY SETCHEL—There is a good deal of difference of opinion among members as to whether it is necessary to bead flues in the front end. I know a great many roads that never think of doing it. The Committee recommend that it is unnecessary to do it. Now, I should like very much to test the sense of this convention as to whether in their opinion it is necessary. In my experience for thirteen or fourteen years I have been in the habit of only just rolling the flue out in the front end and letting it project through the sheet one quarter, or five sixteenths of an inch and I have never had any trouble by doing that. If that can be universally established it is quite a saving in expense.

E. A. CAMPBELL—I have done that for the last five years and never had any trouble.

SECRETARY SETCHEL—I would move it is the sense of this Convention that in practice it is unnecessary to bead flues in the front end.

J. N. LAUDER—I second the motion.

JACOB JOHANN—I hardly think there is any necessity to have this Association express its preference in that matter. I believe each member will do as he likes about it any way. I think it is a local matter. It is very well to discuss it, but I am quite sure that after you pass the resolution that that is about all the effect it will have. I know I will go home and set my flues as I want them, and I think that most of our members will do the same thing.

SECRETARY SETCHEL—The gentleman don't seem to understand the object of this motion. The idea is simply to get at the opinion of the members of this Convention. We thought it was necessary for years to bead flues in the front end. There are a number of the leading roads who are not doing so. It has been my practice not to bead them, and I have found that it not only saves much labor but that it is much better. Now, we come here to learn all we can, and if there is any man here who has always beaded his flues, who should find out that the majority of the members do not think it is necessary to bead flues, why, I think that would be a great justification for him to adopt that practice. The Commi tee say that it is unnecessary to bead flues, and I believe it, and in these days of sharp competition, when everybody is trying to get their expenses down as low as possible, it seems to me of great importance that if we can save one to five dollars on an engine by not beading the front ends of flues it is a practice worth adopting.

R. H. BRIGGS—I had an occasion lately to renew flues, and I have had several inquiries made of me if it was not best to bead at the front end. I have now and then gone so far as to run a bolt from one end to the other, and finally concluded that I had better bead the front end and allow the flue to act as a stay. I think beading is necessary. Of course the roller expander will do this work to a certain extent, but if we admit that there is no necessity for beading the flues in this day of big boilers we have got to admit that there is no necessity of stays there. I think, as regards strength, that beading the flues would be just the thing, at least until we come within about four flues of the shell all around.

Mr. Johann says that he does not think it is necessary to get the expression of this Convention on this subject. I think it is necessary, and I want to say that I think there are expressions made here and subjects voted on which are not considered by the members properly. When a subject is to be voted on, let the members stand up and vote, and you will find a great many times that the vote wouldn't be very heavy on the yeas. I find that there are members that vote to adopt so and so, and yet don't do it, don't carry out what they vote to do. I believe that if a member votes to adopt anything, and if that thing is adopted, I think that member should not be ashamed to carry it out and should stand up for it. (Applause).

ALLEN COOK—I fully agree with Mr. Briggs in regard to beading flues in the front end. I do it for a stay. I did it first because the flue sheet bulged. I think we require still more stays. I bead my flues on the front end, and I believe it is best to do so.

JACOB JOHANN—I rise to make a personal explanation. If any of the members understood me to say that I didn't believe in discussing these matters, then I certainly didn't make my meaning clear. What I meant to say was that I didn't think it was necessary to take a vote on this subject. I don't think that we want to adopt it as the sense of this Association. I hope the members will understand that I am ready and willing to have everything fully discussed. The only trouble is that things are not sufficiently discussed sometimes.

R. H. BRIGGS—I have always been taught to believe, and I come here with that understanding, that the opinion of this Association is considered authority for the guidance of others outside of the Association, as well as among our own members. We come here to discuss matters, and yet we arrive at no decision in nine cases out of ten. For instance, on the question of standards. Ever since I have been a member of the Association there has been brought up here different ideas in reference to standards, and yet I don't think we have adopted one single

standard worthy of note. Now, what we want is, to get some idea from the Association with reference to beading flues, and we should try to educate the people as to what we think is the best plan of putting in a flue, and, if it is necessary for any reason to bead them at both ends, let us say so emphatically, and let it go out from us as authority. We want to look at our reports with pride, and when we decide upon any certain point we want to stand by it, and say that we know that it is the best plan. While I think this matter of beading flues is a mechanical necessity in a large boiler, there are others who do not think so; and we want to have a full expression of opinion on this subject.

J. S. McCrum—My experience in this matter has been very similar to Mr. Briggs'. In former years, when we had smaller boilers, I used to set my flues with the expander in the front end, but after we got to having larger boilers and carrying a heavier pressure, I found difficulty with the back flue sheet bulging out. Consequently, I have adopted the practice of beading the flues at both ends, and I think in such cases it is a necessity.

John Black—It has been our practice to do just as Mr. Briggs does, but of late years we take the front flue sheet and concave it three-eighths to one-half an inch, and the pressure of the boiler coming against that prevents it from coming out. The same can be done with the flue sheet at the back end, and produces the same result. But when the sheet is put in straight, we set about so many of them in the center in order to stiffen the sheet. But the other way we find of late is a very much better way.

J. N. Lauder—I think the question of the necessity of beading flues in large boilers rather than in small ones is not attributed to the right cause. If the flues are set three-quarters of an inch apart there is no more weakness to the sheet in a large boiler than there is in the small one, the flues acting as stays. The only pressure you get endwise in either case is the space between the flues. I attribute the difficulty, that Mr. McCrum refers to, to a defective circulation of water. The back-head gets over-heated, and pulls off the flues. I can see no reason why, if the water circulates properly, there should be any more necessity for beading the flues in the large boiler than in the small one. I consider it entirely unnecessary, so far as strength, durability, and prevention of leakage is concerned, to bead either end of the flues when set by a dudgeon expander.

C. Hackney—I am in about the same location as my friend Mr. McCrum is, as to bad water. We have got some very bad water, and we have some very large boilers. We do nothing with the flues in our front ends but roll them. We have never had any trouble with sheets

springing or bulging. We don't keep flues in over five months on account of the boilers filling up with mud. We have no necessity for beading our boilers in the front end, either in the center or elsewhere. I use just a plain roller for the front end.

J. S. McCrum—The distance between our flues is three-quarters of an inch, which I presume is about the usual practice in the West. In the case of large boilers, where the tube sheets have been sprung, I found that the boilers were comparatively clean. The back sheets were straight. I have never been in the habit of concaving, which Mr. Black said was his practice.

John Black—It was the front sheet that I concaved.

Mr. McCrum—Of course the method of expanding our flues is with the dudgeon expander.

C. Hackney—I wish to ask which end of the boiler the flues would pull out from?

J. S. McCrum—The back end.

C. Hackney—That shows to me plainly that the front end, expanded with the roller, is sufficient for that purpose, if the beaded end will pull out first.

G. W. Stevens—It is our practice to bead the flues at both ends, for the simple reason that has been set forth by Mr. Briggs and several others. Mr. Lauder said that the larger boilers had no more pressure than the smaller ones. I think if he can demonstrate that it will be a unique thing.

J. N. Lauder—If I was so understood, I am very glad Mr. Stevens has brought the matter up. That was not my meaning. I admit there is more aggregate pressure, but there is also more stays in the large boiler. What I meant was that there is no more pressure to pull each individual flue through the sheet in a large boiler than there is in a small one, provided they are all the same distance apart.

R. H. Briggs—I would like to ask Mr. McCrum, referring to Mr. Hackney's last remark, if he didn't always observe that when his back flue sheet left the flue that the bead had either worn off or had been broken off by abrasion.

J. S. McCrum—Yes, sir, it is usual when the flues have had considerable wear and the beads begin to get a little weak.

F. B. Miles—I think it is important that we should record our vote upon this motion that the Secretary has made, and in fact there is one thing that has been omitted from the discussion, but no doubt it has been present in the minds of all members, and that is this: The development of expansion in the water shell and in the tubes. Some of the members

have stated that the beaded ends of the front sheet are needed in order to stay the boiler. Now, I think if they bead those flues when they are cold that when the boiler is fired up the tubes won't be very much of a stay. As some of the members think that the front ends of the tubes need not be beaded, and others think they should be, and as some possibly may think if they wanted to stay the boiler they might bead the flues a certain distance apart, it seems to me very important, for the guidance of those who choose to take our guidance, that we should vote on the Secretary's motion.

J. McKENZIE—I had hoped that I was going to be the only one to advocate beading of the flues at the front end of the boiler. Some years ago I made a very practical test of it. We were at that time troubled with very bad water, and we found it was almost impossible to keep the flues from leaking in the front end of the boiler. We rolled the flues in the front end and beaded in the back end. I said to our boiler maker that we must try some method to remedy the trouble, and suggested beading them on the front ends. He did so, and he put the engine in the shop with another one. Both engines were put on the road and ran about six months. The engine that had the boiler beaded in the front end never gave us any trouble at all, while the other engine that was not beaded was continually being tinkered at. It may be that we didn't know how to put the flues in with the roller expander, but we were very careful about it, and I thought we were doing the best that could be done. Western men, I think, have a great deal of trouble with their flues, and I think they will generally say that the flues should be beaded on the front end.

M. L. COLLIER—We live in a progressive age, and some men are charged occasionally with carrying wheat in one end of the sack and rock in the other. It has been our custom in the south, more especially on the road I am connected with for twenty-six years to roll our flues at both ends. We have never had any trouble in doing it that way. Now, if it is the sense of this Convention that it is useless to roll—

SECRETARY SETCHEL—(Interposing). The recommendation of the committee was that it was not necessary to bead, and that was the motion.

M. L. COLLIER—Yes, I understand: if rolling alone will answer in the front flue sheet, then it is a question of economy not to bead. I have always had good results from beading. I never had any flue pull through or crack. I am very glad this question has taken the course it has, because some of us may be enlightened on the subject.

CHARLES BLACKWELL—I would propose as an amendment to Mr. Setchel's motion that the words, "When good water is used," be added.

G. W. STEVENS—What is good water? Just explain that.

CHARLES BLACKWELL—I should call water good if we could run for six weeks or two months without washing out your boiler.

J. N. LAUDER—I hope Mr. Blackwell won't insist upon that amendment. We have evidence from gentlemen who have bad water that they do not bead their flues. We also have evidence from gentlemen who have good water that they do bead their flues. Now, I think we can take the sense of this Convention upon this question. It is a question for western men almost exclusively.

CHARLES BLACKWELL—I shall be quite happy to withdraw the motion, if it does not give satisfaction.

[A vote was then taken on the motion of Secretary Setchel, and it was carried: Ayes, 46; Nos, 28.]

On motion of J. McKenzie, the discussion on this report was closed.

JACOB JOHANN—I would ask unanimous consent to bring up a matter that can be settled in a moment. It is to place certain of our old members on the honorary list. The names are C. T. Parry, P. J. Perrin, E. H. Williams, and H. G. Brooks. They have been active members of the Association, and they have now arrived at that age when they are getting a little weary, and want rest. I, therefore, think it would be proper to compliment them by placing their names on the list of honorary members of the Association.

JOHN BLACK—I second the motion.

(Carried.)

THE PRESIDENT—The report of the Committee on "Shop Tools and Machinery" will be now read.

[The report referred to was read, and, on motion, received.]

REPORT OF COMMITTEE ON SHOP TOOLS AND MACHINERY.

To the American Railway Master Mechanics' Association:

GENTLEMEN:—Your Committee on Shop Tools and Machinery beg to herewith submit the following report:

By dealing with but one subject, the Committee hoped to gather more valuable and accurate information, than would likely be obtained if an attempt were made to cover a larger and wider field.

They accordingly caused to be issued for distribution, the following circular:

"Please state if you have used Milling Machines instead of

Planers for surfacing work. State kind of work surfaced, and difference of time in favor of either machine.

"It is not necessary to give the number of hours occupied by a machine in performing a certain amount of work, the result, if given in form of a percentage in favor of one or the other machines, will answer quite as well, the object being simply to ascertain which is the cheaper method, and to what extent."

Replies to this circular were received from ten members, five of whom reported more or less experience with milling machinery.

Mr. J. Davis Barnett believes that the value of milling begins and ends with small surfaces; that when large surfaces are to be dealt with, the expense of keeping up cutters runs away with all profit

Mr. Jacob Johann considers the Milling Machine as the equivalent of half a dozen special machines, and is decidedly in favor of special machinery.

Mr. A. M. White thinks there is a gain of 10 to 20 per cent. in favor of milling, where the work is of such shape that the cutters can work freely.

Mr. H. N. Sprague has milled rod boxes successfully for several years, at a much less cost than planing, but is of the opinion that the great cost of cutters for other work neutralizes what advantage the Milling Machine may have over the Planer.

Another member writes, that in the establishment with which he is connected, milling is almost the only method used for finishing the strap fits of rod boxes. The bottom, sides and edges of flanges are surfaced at one cut, as accurately as can be done by an expert on the planer, and at about half the cost for labor, the same help having been transferred from the Planer to the Milling Machine.

He considers the Milling Machine as possessing advantages over the Planer, for surfacing many kinds of both large and small work. When cutters of any considerable size are to be used, he thinks they should be made with inserted and adjustable teeth, that is, the teeth should be held in an iron or steel head, as this admits of easily replacing them when they become broken or badly worn.

To those who believe that only small work can be advantageously surfaced by the milling process, he refers to the huge milling ma-

chine known as the Rotary Planer, so successfully used by bridge and roof builders, for finishing ends of chords, posts, and other members of structural work. Here is milling on a large scale, a cast or wrought iron head, in which are held many cutters similar to those of the lathe or planer, simple, cheap and effective, a machine capable of surfacing work 48 inches in width and of indefinite length, with such rapidity and accuracy that the planer ceases to be a competitor, and he thinks it fair to assume that a similar machine would back off cylinders as quickly and as accurately as it does the work upon which it is commonly engaged.

This member is also of the opinion that the common idea, that large milling tools are too expensive to be of practical value, is not well founded. Large milling cutters, if fitted with inserted teeth, are not more expensive to keep up than a given number of lathe and planer tools of similar dimensions.

If, however, large cutters are to be made from the solid, thus giving the tool dresser an opportunity to undo the machinist's labor of days, and perhaps weeks, we are dealing with unsafe methods, rather than with wrong principles. With such cutters the Rotary Planer would surely become a complete failure as a labor saver; therefore, they who attempt to do any considerable amount of milling with large solid cutters are not likely to become converts to this method of surfacing work. But with the well-designed Milling Machine, and properly constructed cutters, he believes the question of Milling versus Planing, will, in very many cases, be decided in favor of the former machine.

D. A. WIGHTMAN,
A. J. PITKIN,
F. B. MILES,
Committee.

THE PRESIDENT—The report is now open for discussion.

G. W. STEVENS—I move that discussion on that report be dispensed with, and the regular order of business taken up.

R. H. BRIGGS—I second the motion.

(Carried.)

J. N. LAUDER—I have a letter here that has just been presented to me, which, if there is no objection, I will read. It is from the Meigs' Elevated Railway.

EAST CAMBRIDGE, Mass., June 17, 1886.

Joel H. Hill, Esq.:

MY DEAR MR. HILL—Mr. Doane tells me that he was told, last night, that there was a general desire expressed by the Master Engineers here to see what I am about. I had not thought it worth while to inflict my work, entirely outside of the current railway, upon their attention. If it is their desire, I shall be glad to see them at their convenience, to-morrow, or at any time they may say. I shall need no warning, except to know that I must be at home at the selected hours. You are aware of the state of my work, and I will not recount that; but, with the model and the engine as it stands—the tracks, etc., etc., etc.—they will have lost nothing in visiting our works. I am very truly, JOE V. MEIGS.

[Referred to Committee on Resolutions.]

THE PRESIDENT—The next report is that of the Committee on "Hammer Blow Test of Locomotives," which will be read by the Secretary.

[The report was read, and, on motion, received.]

ELIZABETH, N. J., June 11, 1886.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, appointed at last annual meeting, to consider and confer with a similar committee of the Franklin Institute of Philadelphia, Pa., looking to the weighing of hammer blow, or variation of pressure of locomotive driving wheels on the rails of a railway, would respectfully report as follows, viz: That it was originally intended that a test of this subject would be made at the "Novelties" Exhibition, held in Philadelphia during the month of September, 1885. It was, however, found to be impracticable to make such test at that time. Your Committee, however, met with Franklin Institute Committee, September 24, 1885, as a Joint Committee to consider the subject. Mr. Thomas Shaw, M. E., of Franklin Institute, was chosen as Chairman of the Joint Committee, and Mr. F. W. Dean, of Master Mechanics' Association, was chosen as Secretary of the Joint Committee. At request of Mr. Charles Blackwell, he was relieved from

service on your Committee, and Mr. Coleman Sellers was appointed to serve in his place.

The Joint Committee consisted of the following:

THOS. SHAW, M. E.,
PROF. S. W. ROBINSON,
PROF. P. H. DUDLEY, M. E.,
THEO. N. ELY,
EDWARD LONGSBRATH,
For the Franklin Institute.

WM. WOODCOCK,
COLEMAN SELLERS,
T. L. CHAPMAN,
ANGUS SINCLAIR,
F. W. DEAN,
For the American Railway Master Mechanics' Association.

A number of meetings were held, and the subject fully and thoroughly discussed, and your Committee would present, for the consideration of the Association, the annexed report of Joint Committee, which is accompanied with drawing and description of the proposed apparatus for making practical test of this subject.

Very respectfully,

WM. WOODCOCK, *Chairman,*
F. W. DEAN,
ANGUS SINCLAIR,
Committee.

Report of the Members of the Joint Committee of the Franklin Institute and American Railway Master Mechanics' Association, to investigate the Hammer Blow, or Magnitude and Variation of Pressure, of Locomotive Driving Wheels, on the rails of a railway.

We respectfully report that your Committee has held meetings from time to time, extending over a period of eight months, and have written to and kept posted any absent members of our Committee, in order that all the members of said Committee could have a correct understanding of our work and give written suggestions where their presence was impracticable.

Our Committee, being composed of professional men, on active duty in different portions of the United States, it was possible to assemble only one-half of its members at any one time.

The work of our Committee, though of a seeming simple character, was in a measure problematic, and in a direction that has occasioned much diversity of opinion amongst leading engineers and scientists, many of whom contend that there is no wave force, or so-called hammer blow, from imperfect balancing, etc., and some of our Master Mechanics maintain that their locomotive driving wheels are in perfect balance, etc.

It is, however, self-evident upon careful observation, that, to balance any vibrating weight moving in a horizontal plane, by counter weights in the crank wheel moving in a vertical plane of rotation, that wherever the balance is made perfect in the horizontal direction, it is out of balance in the crank wheel in a vertical direction equal to a large portion of the counter weight employed to correct the horizontal movement. In view of this fact, we find that engines considered most perfectly balanced by counter weights in the crank wheel, do occasion great disturbance in a vertical direction (causing a wave force, that may be compared to a hammer blow), that has a measure of destructiveness upon rails and bridges dependent on weight and velocity of moving parts, and that it is worthy of the most careful examination and test. The forces induced on both sides of the engine, from this cause, are of a complex character, varying greatly, under modifying conditions that occur in practice, that does not submit readily to calculation.

We deem a test of this peculiar action of such importance that we recommend that it be subjected to accurate measurement by means of a special Dynamometer that your Committee has specially devised, and which we believe is competent for the purpose. We believe, also, that it will give a correct showing of the complicated and destructive force complained of, and show its exact value, which test may be regarded as causing the application of such remedies as may hereafter be provided to correct any evident damage in the direction referred to.

A description of the proposed Dynamometer is hereto annexed, the cost of which, erected in place exclusive of ground, but cov-

ered by a frame building, is estimated to be $6,000. Your Committee, having performed their services gratuitously, are not expected, of course, to provide the ways and means to procure the proposed test apparatus.

It has been suggested, however, that since the advantage of any test would be with the railroad companies that possibly these companies would unite in providing the needful apparatus, and that in case it was provided as described, the Franklin Institute might be intrusted with the charge and possible ownership of the same for the use of all railroad companies.

The above estimate includes the expense of Prof. P. H. Dudley's Recording Apparatus.

SIGNED:

THOMAS SHAW, M. E., *Chairman.*
F. W. DEAN, *Secretary.*
} *Joint Com.*

MAY 31, 1886.

ANGUS SINCLAIR—As a member of that committee, I would like to say a word or two about the sub-committee's report. I was unable to attend those meetings, or I should have objected to some of the assumptions that are made in that supplemental report, which I think are made on insufficient data.

THE PRESIDENT—The report has been received now.

J. N. LAUDER—I understand that Mr. Coleman, one of our associate members, who was to read a paper before this Convention, has not been able to prepare his paper, but he is present, and I will therefore move that he address us, and that his remarks be limited to thirty minutes.

(Carried.)

ADDRESS OF JOHN A. COLEMAN, OF PROVIDENCE, R. I.

MR. CHAIRMAN AND GENTLEMEN—I regret that the gentleman who made the motion that thirty minutes be allowed for my remarks, did not limit the time to three minutes, which would have been ample for an explanation and an apology to the Convention. I was rash enough some time ago to promise to prepare a paper for this occasion, the fulfillment of which prior engagements have absolutely prevented.

I would greatly prefer to be let off altogether, but I do not like to break down when expected to do anything; and if you have the patience to listen for a few minutes to the reflections of an outsider, I will endeavor

to put what I have to say in as concise form as I can, and in such manner as will do no harm, even if it does no good.

For many years I was connected with Steam Engineering. I was once with the Corliss Steam Engine Company, and afterwards was the agent of Mr. Joseph Harrison, of Russian fame, for the introduction of his Safety Boilers.

That brought me into contact with the heavy manufacturers throughout the Eastern States, and during that long experience I was particularly impressed with a peculiarity common to the mill owners, which I believe it may be said with truth is equally common to those interested in locomotive engineering, namely, how much we overlook common every-day facts. For instance, we burn coal; that is, we think we do, and boilers are put into mills and upon railroads, and we suppose we are burning coal under them, when in reality we are only partially doing so. We think that because coal is *consumed* it necessarily is *burned*, but such is frequently very far from the fact.

I wish upon the present occasion to make merely a sort of general statement of what I conceive to be *combustion*, and what I conceive to be a boiler, and then to try to make a useful application of the reflection to the locomotive.

Treating first the subject of Combustion, let us take the top of the grate-bars as our starting-point.

When we shovel coal upon the grate-bars and ignite it, what happens first? We separate the two constituents of the coal, the carbon from the hydrogen. We make a gas-works.

Carbon by itself will burn no more than a stone; neither will hydrogen. It requires a given number of equivalents of oxygen to mix with so many equivalents of carbon, and a given number of oxygen to mix with so many of hydrogen to form that union which is necessary to produce heat. This requires *time*, space, and air, and one thing more, viz.: *heat*.

I presume that most of you have read Chas. Y. Williams' treatise upon "Combustion," which was published many years ago, and which, until recently, was often quoted as an absolute authority upon the art of burning fuel under boilers.

Mr. Williams in his treatise accurately describes the Chemistry of Combustion, but he mislead the world for fifty years by an error in reasoning and the failure to discuss a certain mechanical fact connected with the combination of gases in the process of combustion. He said, "What is the use of heating the air put into a furnace; if you take a cubic foot of air, it contains just so many atoms of oxygen, neither more nor less. If the air be heated you cause it to assume double its volume,

but you have not added a single atom of oxygen, and you will require twice the space for its passage between the grate-bars, twice the space in the furnace, which is a nuisance; but if the air could be frozen, it would be condensed, and more atoms of oxygen could be crowded into the cubic foot, and the fire would receive a corresponding advantage." Now, Williams proceeded upon this theory, and died without solving the perplexing mystery of as frequent failure as success which attended his experiments with steamship boilers. The only successes he obtained were misleading, because they were made with boilers so badly proportioned for their work that almost any change would produce benefit.

Successful combustion requires something more than the necessary chemical elements of carbon, hydrogen, and oxygen, for it requires something to cook the elements, so to speak, and that is *heat*, and for this reason: When the coal is volatilized in the furnace, what would be a cubic foot of gas if cold, is itself heated and its volume increased to double its normal proportions. It is thin and attenuated. The cold air which is introduced to the furnace is denser than the gas.

With dampers wide open in the chimney, and the gases and air passing into the flues with a velocity of forty feet per second, they strike the colder surface of the tubes, and are cooled below the point of combustion before they have had time to become assimilated, and although an opponent in a debate upon steam boiler tests once stated that his thermometer in the chimney showed only 250 degrees, and indicated that all the value that was practical had been obtained from the coal, I took the liberty to maintain that a chemist might have analyzed the gases and shown there were dollars in them; and that if the thermometer had been removed from the chimney and placed in the pile of coal outside the boiler, it would have gone still lower; but it would not have proven the value to have been extracted from the coal, for it was not the complete test to apply.

The condition of things in the furnace may be illustrated thus: If we should mingle a quart of molasses and a gallon of water, it would require considerable manipulation, and some *time* to cause them to unite. Why? Because one element is so much *denser* than the other; but if we should mix a quart of the gallon of water with the quart of molasses, and render their densities somewhere near the density of the remaining water, and then pour the mass together, there would be a more speedy commingling of the two. And so with the furnace. I have always maintained that every furnace should be lined with fire-brick in order that it shall be so intensely hot when the air enters, that the air shall *instantly* be heated to the same degree of tenuity as the hot gases themselves, and the two will then unite like a flash—and that is heat. And here is

the solution of the Williams' mystery of failure, when cold air was introduced upon the top of a fire to *aid* combustion. The proof of the necessity for heat to aid the chemical assimilation of the volatilized coal elements, is seen in starting a fire in a common stove. At first there is a gas-works, and blue flame in which the hand may be held; but wait until the lining becomes white hot, and then throw on a little coal, and you will find a totally different result. It is also seen in the Siemens' Gas Furnace, with which you are doubtless familiar. There is the introduction of gas with its necessary complement of air. Until the furnace and retorts become heated, the air and gas flutter though only partially united, and do little good; but as soon as the retorts and furnace become thoroughly hot, the same air and gas will melt a fire-brick.

These are common phenomena which are familiar, but apt to be unnoticed; but they logically point to the truth that no furnaces should present a cooling medium in contact with fuel which is undergoing this process of *digestion*, so to speak. It will be very evident, I think, from these facts, that water-legs in direct contact with a fire are a mistake. They tend to check a fire as far as their influence extends as a thin sheet of ice upon the stomach after dinner would check digestion, and for the same reason, namely, the abstraction of heat from a chemical process. If fire-brick could be laid around a locomotive furnace, and the grate, of course, kept of the same area as before, it is my belief that a very important advantage would be at once apparent.

An old-fashioned cast iron heater always produced a treacherous fire. It would grow dead around the outside *next the cold iron*—but put a fire-clay lining into it, and it was as good as any other stove.

If I have now made clear what I mean by making heat, we will next consider the steam boiler. What is a steam boiler? It is a thing to absorb heat. The bottom line of this science is the bottom of a pot over a fire, which is the best boiler surface in the world; there is water upon one side of a piece of iron, and heat against the other. One square foot of the iron will transmit through it a given number of units of heat into the water, at a given temperature in a given time: two square feet twice as many, and three, three times as many, and so on. Put a cover upon the pot, and seal it tight, leave an orifice for the steam, and that is a steam boiler with all its mysteries.

The old-fashioned plain cylinder boiler is a plain cylindrical pot over the fire. If enough plain cylinder boilers to present the requisite number of square feet of absorbing surface are put into a cotton mill, experience has shown that they will make a yard of cotton cloth about as cheaply as tubular boilers. If this is so, why do not all put them in?

Because it is the crudest and most expensive form of boiler when its enormous area of ground, brick-work, and its fittings are considered. Not all have the money or the room for them. To produce space, the area is drawn in sidewise and lengthwise, but we must have the necessary amount of square feet of absorbing surface, consequently the boiler is doubled up, so to speak, and we have a "flue-boiler." We draw in sidewise and lengthwise once more and double up the surface again, and that is a "tubular-boiler." That includes all the "mystery" of that subject.

Now we find among the mills, just as I imagine we should upon the railroads, that the almost universal tendency is to put in too small boilers and furnaces. To skrimp on boilers is to spend at the coal yard. Small boilers mean heavy and over-deep fires, and rapid destruction of apparatus. In sugar houses you will see this frequently illustrated, and will find sixteen-inch fires upon their grates.

We have found that as we could persuade mill owners to put in more boilers and extend their furnaces, so that coal could be burned *moderately* and *time* for combustion afforded, we often saved as high as one thousand tons in a yearly consumption of four thousand.

Now, when the ordinary locomotive sends particles of coal into the cars in which I am riding, I do not think it would be unfair criticism to say that the process of combustion was not properly carried out. When we see dense volumes of gas emitted from the stack, it is evident that a portion of the hard dollars which were paid for the coal, are being uselessly thrown into the air; and it will be well to remember that only a little of the unburnt gas is visible to the eye.

One point I wish to make is this: we find, as I have said, that as we spread out with boilers and furnaces in the mills, so that we can take matters deliberately, they save money.

Now, coming again to locomotives. I think if we examine the subject carefully, the fact will strike us a little curiously. The first locomotive built in Philadelphia weighed about fourteen tons. Judging from the cut I have seen, I should think her furnace might have been thirty inches square. We have gone from that little fourteen ton engine to machines of fifty and sixty tons—perhaps more. The engines have been increased over four times, but I will ask you if the furnace areas have been increased in proportion. Some of the furnaces of the engines are six feet by three, but that is an increase of less than three to one of furnace, as against four to one of weight of engine. When my attention was first called to this matter I had supposed, as most people do who are outside of the railway profession, that there was something subtle and mysterious about railway engineering that none but those brought up to the business

could understand. Possibly it is so, and I am merely making suggestions for what they are worth, but I think the position I have taken in this matter was established by some experiments of three weeks' duration, which I conducted between Milan and Como, in Italy, for the Italian Government, in pulling freight trains up grades of one hundred feet to the mile. The experiments were made with an engine built by the Reading Railroad.

We competed with English, French, Belgian and Austrian Engines. These machines required the best of fuel to perform the mountain service, and could use coal-dust only when it was pressed into bricks.

We used in the Reading Railroad machine different fuels upon different days, making the round trip of one hundred and twenty miles each day with one kind of fuel.

We used coal dust scraped up in the yards, also the best Cardiff coal, anthracite, and five kinds of Italian lignite, the best of which possesses about half the combustible value of coal.

The results in drawing heavy freight trains were equally good with each kind of fuel, the engine having at all times an abundance of steam on heavy grades, no smoke, nor cinders, and no collection of cinders in the forward part of the engine.

The fireman arranged his fires at a station, and did little or nothing except to smoke his pipe and enjoy the scenery until we reached the next station. An incident occurred to prove that we were not playing with the machine. They told me one morning that we should be given a load 25 per cent. less than the maximum load of an engine of her class (thirty tons). We started up the 100-foot grade and found we could barely crawl, and our engineer got furious over it; he thought they were repeating a trick, already attempted, by screwing down a brake in ascending a grade, which we had detected, however, and found a pair of wheels nearly red hot. Upon this occasion we found nothing amiss, except full cars where they had reported only a light load. *We pulled to the top of the hill, the steam blowing off furiously all the time.*

This was a new experience to the Italians, and might surprise some Americans.

When we arrived at the station the Inspector-General and his corps of engineers were evidently amazed, and it was evident we had captured them. He said to me: "I can congratulate you, Signore, on possessing a superb machine."

Afterwards, one of the engineers said to me, "Do not let it be known that I told you what you have heard, or I shall lose my place; but you have drawn *fifty* per cent. more than the maximum load of one of our

forty-ton engines." I said: "You attempted to 'stall' us, and when you try it again, be fair enough to give me a flat of pig-iron, and as you pack cars on one end, I will pack pig iron upon the engine until she will stick to the track, but rest assured that you will not be able to get that steam down." The experience with that engine proves conclusively, to my mind, that the general principles of steam making are the same for both stationary and locomotive practice. The grand secret of the success of that Wootten engine was the enormous area of the grate surface, being, if I remember correctly, seven (7) feet by nine (9), permitting thin fires to be carried, and complete combustion to be obtained, before the gases reached the boiler tubes. An enormous crown sheet was presented, and that is where the bulk of the work of any boiler is done.

Thin fires accomplish this: As already stated, a given amount of coal generates a given amount of gas; and this gas requires a given amount of air, or oxygen. This air must be supplied through the grate bars, and then pass through the interstices of the mass of heated coal. It requires about ten (10) cubic feet of air to consume one cubic foot of gas. In stationary boilers we find that if we use "pea and dust" coal, an extremely thin layer must be used, or the ten feet of air, per foot of gas, cannot pass through it; if "chestnut" coal be used, the thickness may be increased somewhat; "Stove" size allows a thickness of six inches, and "Lump" much thicker, if any wise man could be found who would use that coarse, uneconomical size. Of course, I am speaking of anthracite coal. Opinions differ about "Soft Coal," but the same general principle applies, as regards an unobstructed passage of air through the hot bed of coal.

Now, it will be agreed that the locomotive of the future must be improved to keep up with the times. Fierce competition requires increased efficiency and reduces expenses.

I am told by your railroad gentlemen that the freight business of the country doubles every ten years. Trains follow close upon each other. What are you going to do? Are you to double, treble, or quadruple your tracks?

It seems to me much remains yet to be done with the locomotive. We must burn a great deal less coal for the steam we make, and after we have made steam, we must use that steam up more thoroughly. In the short cylinder required by locomotive service, the steam entering at the initial pressure, pushes the piston to the opposite end, and it then rushes out of the exhaust, strong enough to drive another piston. Of every four dollars' worth of coal consumed, at least two dollars' worth is absolutely thrown away. Or, of every ten thousand dollars spent for fuel, five thousand dollars are absolutely wasted. How can we save this? It

would seem obvious, that if steam rushes from the exhaust of an engine *strong enough to drive another engine*, the common sense of the thing would be to *put another engine* alongside, and let the steam drive it, and we should get just so much more out of our four dollars' worth of coal.

It seems evident that we must follow the lead of the steam-ship men, and compound the locomotive engine, as they have done with the marine engine.

Next we must attack the extravagant furnace and increase its area, and reduce the depth of the bed of coal.

The difficulty of making this change seemed to me to be removed on examining an engine on the Providence & Bristol Railroad the other day. The machine was made at the Mason Works, of Taunton. It was an engine and tender combined, the truck being at the rear end of the tender, and the drivers placed well in advance of the fire-box, so that the maximum weight of both engine and tender rested upon the drivers.

In thus removing the drivers from the proximity of the fire-box, abundant facility is afforded for widening the fire-box to an extent to obtain a grate area as large as that of the Wootten engine, or of a stationary boiler.

It seems to me the increase of grate area can be obtained only by *widening*; for a *length* of more than six or seven feet is very hard upon the fireman.

You certainly cannot get more power by deepening present fire-boxes, except by an enormously increased waste of fuel, which all will concede is already sufficiently extravagant.

In arriving at the conclusion of these hasty, and, I fear, somewhat incoherent remarks, I would say that the object arrived at for the improvement of the locomotive would be reached in first making steam *economically*, by employing such increased grate area as will permit running thin fires and moderate or comparatively slow draft; and, secondly, in *economically using* the steam which has been *economically made*, by compounding the engine.

I have given you the views of an "outsider" who has had a somewhat extensive experience in stationary engineering, and who has observed locomotive practice in many parts of the world. These views are offered for what they are worth as suggestions for future thought in designing engines, and as a sort of refresher upon rudimentary points which long familiarity with every-day phenomena causes us at times to overlook.

I trust that our deliberations may aid in the speedy reduction of the expenses of the transporting of freight and passengers, for the benefit of

the Railroad Companies, and, in their turn, the advantage of the people at large.

THE PRESIDENT—We are very much obliged to Mr. Coleman for his excellent address. It is now twelve o'clock, and the regular noon hour discussions are in order.

THE SECRETARY—There are no questions.

[On motion of H. N. Sprague the five-minute discussions were dispensed with, and the regular order of business was resumed.

THE PRESIDENT—The Committee on Subjects is next in order.

[The report of the Committee on Subjects was then read by Charles Blackwell, and, on motion, received.]

The Committee on Subjects for Consideration at the Next Annual Meeting beg to report that they have received the following communication bearing upon the matter:

PORT HOPE, Ontario, Canada, November 6, 1886.

J. M. Boon, Esq., Chairman of Standing Committee on Subjects, American Railway Master Mechanics' Association:

DEAR SIR—It has occurred to me that it would simplify and perhaps improve the sometimes hurried work of the "Subject Committee" if suggestions for subjects received and approved of, but not included by the Committee in the proposed list for the ensuing year, were printed in our proceedings, so as to be readily at the service of both Committee and members the following year. Also, it would only be common courtesy to our associate members were we to print in our proceedings a list of suitable subjects for associates' papers, suggested by the members as being, in their opinion, of interest to—and in keeping with the objects of—our Association. Such a list, without in any way limiting the associates' freedom of choice, would, I feel sure, be appreciated by them as a help to the selection of a subject. Therefore, I would propose for your Committee's consideration that, in requesting suggestions for subjects, this year, you ask for them, both for members', committees' and for associates' papers, and that your report to the meeting include not only the working list for the Twentieth Convention, but also a list of all available subjects left over, that would be of

value to the Subject Committee hereafter; also, the suggested list for associates' papers.

To this end, for your consideration, I enclose a few contributions to both lists. Yours truly,

J. DAVIS BARNETT.

Mr. Barnett suggests the following subjects for consideration of members and associates of the Association:

MEMBERS—SUGGESTED SUBJECTS.

1886.

WHEELS.—Proportioning and least weight of cast spoked wheels. Is cast-steel not better than cast-iron? (Lighter, and thus reduce weight not sustained by springs.)

TIRE.—Fastening, shrinking, proportions, methods of warming, or securing by hydraulic pressure only.

AXLES.—Limit for axle mileage in iron and steel. Form and size of journals and collars, etc.

WHEEL SEATS.—Their proportions. If safe to dispense with keying driving-wheels on axles?

TRACTION.—Increasers; various types of and their usefulness?

SPRINGS.—Equalizing levers, and spring gear, also value of India-rubber cushioning.

SLIDE BARS.—Their material, proportioning of surface, grouping, and the relative merits of single, double and quadruple bars.

CROSS-HEADS.—Material, relative advantages of loose and solid pins, proportion and shape of cotters.

SLIDE VALVE.—Setting, and shop equipment for same.

FALSE-VALVE SEATS.—Best metal, and mode of securing.

LINK-MOTION DESIGN.—From what point should centre of radius of link be taken? Where centre of suspension located, and why? Advantages of wide or close centres on links for eccentric-rod connection, or (in other words) the relative advantages of long and short throw eccentrics.

ECCENTRICS.—Split or solid? Brass or iron? Size (if increased diameter means increased friction) wearing surfaces; curved or flat, recessed or in relief? Butt or flat connections for rods?

FRAME.—Forging, relative merits of bar, slab, and compound frames, frame *joints*, if admissible, and best form of joint.

SECURING.—Cylinder and saddles to frame; modes of.

STEAM-REVERSING GEARS.—Their types, usefulness, etc., in comparison with screw and lever reversing.

REGULATOR.—Equilibrium valves, handles, and best form of stuffing-box.

EXHAUST INJECTORS.—Is their use admissible? Description of their different types and peculiarities.

PONY.—Versus the four-wheel truck.

CAB.—Of wood, sheet-iron, or cast metal? Cab curtains and mode of suspending them.

COILED SPRINGS.—For safety valves; best proportions, material and manufacture, tempering, loss of temper and re-tempering.

GAUGES.—Pressure, water, speed and vacuum, a comparison of various makes, value and merits of different types.

SIGNAL LAMPS.—For locomotive use (including head-lights).

BELL-RINGERS.—Automatic.

BAFFLE-PLATE.—Material, and mode of securing in fire-hole.

ARCHES.—Fire-brick, and other; various constructions, modes of support, and general value of.

SAND BOXES.—And their gear, modern modes of applying sand to rail, delivery of dry sand to boxes, and conveniences for sand-drying.

SHEETINGS.—Boiler and cylinder coverings, sheetings and clothing.

BALANCING.—The reciprocating parts of locomotives, methods and various rules used for.

TENDER.—Iron frames for, and iron truck frames.

LUBRICATION.—Devices for oiling from foot-plate, continuous lubrication, and centrifugal oiling.

SMITHING.—Close to size, if economical so to do when work is to be machine-finished?

CASE-HARDENING.—Necessity for, best mediums to use, styes of furnaces, with their relative efficiency and cost.

OFFICE DIALS.—Or graphic records, showing condition of repairs, mileage, and condition of all engines and cars.

RETURNS.—Uniform system for mileage, expenses, prime cost, and departmental charges.

TURN-TABLES.—Design, material, and anti-friction devices.

WEIGHING MACHINES.—For each engine wheel, their various constructions and utility.

FIXED SIGNALS.—From foot-plate point of view.

LIGHTING-UP.—Rapidly, with blast, steam or hot water admitted into cold boiler; describe plant, also plant for washing out with hot water.

COALING-UP.—Various modes of, their cost and efficiency, details and drawings of shoots, cranes, trollies, etc.

CONSTRUCTION.—Advisability, or otherwise, of a railway designing and building all its own rolling stock and power.

HYDRAULIC.—Power for flanging, bending, rivetting and stamping, also for shop and yard capstans, cranes, jacks and boiler testing.

MULTIPLE DRILLS.—Their usefulness. Types and difference in design and motion gear.

SPECIAL TOOLS.—New or old, invented solely to meet necessities of locomotive construction.

SMALL SHOPS.—Versus concentration in large works. Discuss relative merits of.

ANNULAR.—Or longitudinal plan of stalling in engine house. Discuss the relative merits of each.

MOULDING.—Shops, moulding machines, and foundry economy generally.

SHOP.—Lighting, warming, draining and ventilation.

WHEEL PITS.—Various devices for removing truck wheels without lifting locomotives.

WATER.—Picking up water on the run.

WATER.—Station (an ideal or model equipment), with standard boilers, pumps, pipes, valves, hydrants, etc.

SNOW.—And ice, clearing equipment as fitted to locomotives.

WRECKS.—Gear and tackle and staff for promptly clearing.

J. DAVIS BARNETT.

ASSOCIATES—SUGGESTED SUBJECTS.

1886.

COMPOUND.—Locomotives, history (bibliography), present position and prospects.

CONDENSING.—Locomotives, history (bibliography), present position and prospects.

SMALL MOTORS.—For logging, mining, tramways and city passenger railways.

FIRELESS.—Locomotives, history (bibliography) present position, prospects.

OIL, TAR AND GAS.—Burning locomotives.

MOUNTAIN RAILWAY.—Locomotives, including rack and grip-rail.

SODA AND CHEMICAL.—Locomotives.

DEFICIENCIES.—Of modern locomotives.

FUTURE.—Of the locomotive, or of locomotion generally.

COST.—Or price, of locomotives from, 1836 to date, with explanation of the rapid oscillations in market value.

SINGLE ECCENTRIC AND RADIAL.—Valve gears as applied to locomotives, and the present condition of the problem.

CENTRE OF GRAVITY.—Position of, vertically and longitudinally, in the locomotive; and influence of, on its stability at both high and low speeds.

MINING AND UNDERGROUND.—Locomotives.

ELEVATED RAILWAYS.—Specialities in railway practice developed by or resulting from American elevated railways.

FRICTION.—Internal frictional resistances in different modern classes of locomotives.

PISTON SPEED.—High piston speed (or small driving wheel) as an element of economy in American railway practice.

TRAM FRICTION.—And tractional resistances generally, results of dynamometer experiments, etc.

BRAKES.—Relative value and efficiency of various types of.

THE TRUCK.—Its history and development in American practice.

BLOCK SIGNAL.—System of handling trains.

ELECTRIC.—System of signaling.

ARCHITECTURE.—Or workshop and railway building design.

IRON FOUNDRY.—Design of a model.

BRASS FOUNDRY.—Design of a model.

LAYING-OUT OF RAILWAYS.—From mechanical officers' point of view.

FIRMS.—History of American locomotive building companies.

BIOGRAPHY.—Of noted American locomotive engineers and designers, and their more prominent inventions.

LABORATORY.—The necessity for, with plan, design and equipment of chemical and mechanical testing room.

EDUCATION.—Of apprentices, and of skilled staff.

BIBLIOGRAPHY.—Descriptive bibliography of all works of merit on the locomotive, or a suggested list of books that should form the nucleus of the future library of the Master Mechanics' Association.

RESISTANCE.—Offered by workmen to introduction of labor-saving tools; how best dealt with.

THEORETICAL AND MATHEMATICAL INVESTIGATIONS.—Into the stress that comes on crank-pins, side-rods, connecting-rods (more especially those designed for radial valve gear), valve stems, rubbing friction of slide-valve and sliding-bar faces, torsion on straight axles, torsion on wheel seats, etc.

J. DAVIS BARNETT.

NOVEMBER 6, 1886.

Other subjects have been suggested to your Committee, who recommend that the following be reported upon at the next annual meeting:

1. To give best results: what rule should be followed for proportioning the cylinders of an engine, when size of driving wheels, weight available for adhesion, and boiler-steam pressure are given qualities.

2. Traction increasers: their various types and relative merits; also, cases in which their use can be recommended.

3. Cross-heads and guide-bars: the various types in use; the materials used in their construction, and results obtained.

4. Packing: various forms of piston-packing in use, and results obtained; also, most economical and satisfactory packing for

piston-rod, valve-stem, regulator, and air-pump stuffing-boxes, with results obtained.

5. Washing out and lighting up engines: showing best systems in use for washing out, and most economical and expeditious mode of raising steam, and necessary plant for same.

6. Coaling up engines; the various plans in use; their relative cost and efficiency.

7. Standard form of tire-section.

J. McKenzie—I have a subject to add to that report. It is this: "What influence has the man at the throttle upon the wear of the driver tire of the locomotive?" I move that that subject be added.

[The motion to add the subject proposed by Mr. McKenzie was seconded, and carried.

E. A. Campbell—I move that the subject of lubricants generally be added.

A Member—I second that motion.

[The motion was lost.]

L. Finley—I move that the subject of cross-heads and guides be dropped from that list recommended by the report.

E. A. Campbell—I second it.

[The motion was lost.]

Angus Sinclair—I move that the committee's report as amended be adopted.

John Black—I second the motion.

Carried.

The President—The secretary will now read the report of the Committee on Next Place of Meeting.

The Committee respectfully beg leave to report St. Paul, Minneapolis, New York, and Philadelphia.

H. A. Whitney,
C. Blackwell,
M. L. Collier.

J. McKenzie—I move that our next Convention be held at Minneapolis.

M. L. Collier—The Car Builder's Association meet there next year, and I think we should go to St. Paul.

J. McKenzie—Then I withdraw my motion.

Albert Griggs—I move that we meet next year at New York.

R. H. Briggs—I second the motion.

J. N. Lauder—I believe the usual custom has been to ballot for the

place to hold our Convention. I think it would give better satisfaction if we should take a ballot.

JOHN BLACK—I believe Mr. Lauder is right. I have attended a great many meetings, and we have always decided upon the next place of meeting by ballot.

[The motion to hold the next Convention at New York was lost.]

J. MCKENZIE—I now move that the next place of meeting be left to the executive committee, and that the place selected shall be either St. Paul or Minneapolis.

W. F. TURREFF—I second that motion.

G. W. STEVANS—I move that it be decided by a rising vote.

JOHN BLACK—I move that we ballot for the next place of meeting.

J. N. LAUDER—I second that.

THE PRESIDENT—As the motion stands before the Convention?

As I understand it, Mr. McKenzie makes a motion that this Association nominate as the next place of meeting either St. Paul or Minneapolis, and that it be left to the executive committee which place shall be selected. Mr. Stevans offers an amendment that it be taken by a rising vote in place of a vote by ballot.

JOHN BLACK—Why shouldn't we have three or four places named, then, if we are going to ballot?

A MEMBER—Vote this motion down, then, if you don't want to go to Minneapolis or St. Paul.

THE PRESIDENT—I will put the question on taking this vote by rising instead of by ballot.

Carried.

THE PRESIDENT—The motion now before the Convention is that our next Convention be held at Minneapolis or St. Paul, the selection of which of those two places to be left to the executive committee.

[The motion was carried: Ayes, 37; Nos, 30.]

THE PRESIDENT—The motion prevails, and our next Convention will be held at either St. Paul or Minneapolis, as the executive committee may decide.

THE PRESIDENT—The report of the Committee on Resolutions which is next in order, we will let stand over until later. The next business is the election of officers. This election will be by ballot.

J. MCKENZIE—I move that the secretary be instructed to cast the vote of the Association for our present officers for the next year.

THE PRESIDENT—I think the Constitution is against you on that.

[On motion of Mr. Briggs, a recess of five minutes was taken.]

[RECESS.]

J. N. LAUDER—It has been thought best by a good many of the members that no nominations should be made. I think that is eminently proper in a body of this kind, but I would like to say that I think Mr. William Woodcock, who is our first vice-president and an old member of this Association, should be elected President.

JAMES MEEHAN—Mr. Lauder is out of order. He says he is opposed to nominations being made, but at the same time he gets up and makes a nomination.

THE PRESIDENT—The vote will now be taken for President.

[The result of the balloting for President was as follows: whole number of votes cast, 70, of which William Woodcock received 48; J. H. Setchel, 13; J. Davis Barnett, 8; and one blank.]

[On motion of G. W. Stevans, the nomination of William Woodcock was made unanimous by a rising vote.]

THE PRESIDENT—I have much pleasure, Mr. Woodcock, in announcing that you are elected President of this Association.

W. WOODCOCK—Mr. President, and gentlemen of the Convention: Through the kindness of this Association, in 1869, I was permitted to become a member. I always considered it an honor to be associated with its members, and in all that time I have received very kindly recognition. It has been to me a source of great plasure and profit to be considered one of your number, and when you have imposed upon me honors I have felt, and do now feel, for this added honor, especially grateful. I feel that words are insufficient for me to express my thanks to you. Suffice it to say, gentlemen, that with your cordial co-operation, as it has been given to me in the past, I shall assume the duties of this office with the high purpose to labor for the best interests of the Association. Gentlemen, I thank you. [Applause.]

THE PRESIDENT—The vote will now be taken for first Vice-President.

[The result of the vote for first Vice-President was as tollows: Whole number of votes cast, 66, of which Jacob Johann received 54; R. H. Briggs, 4; Wm. Fuller, 1; Allen Cook, 2; W. F. Turreff, 2; John Black, 1; and two blanks.]

[On motion of R. H. Briggs, the election of Jacob Johann as first Vice-President was made unanimous by a rising vote.]

JACOB JOHANN—Mr. President, and Gentlemen: I thank you for this expression of your confidence, and I shall try to do my duty in the future as I have tried to do it in the past. [Applause.]

THE PRESIDENT—The vote will now be taken for second Vice-President.

[The result of the vote for second Vice-President was as follows: Whole number of votes cast, 66, of which R. H. Briggs received 53; and

George Richards, 1; Wm. Fuller, 1; Jacob Johann, 1; James Meehan, 2; G. H. Colby, 2; Geo. Hackney, 3; Charles Blackwell, 3.]

[On motion of H. N. Sprague, the election of R. H. Briggs for second Vice-President was made unanimous by a rising vote.]

R. H. BRIGGS—I must say I am surprised. Consequently, I have no speech for the occasion, but I will reiterate what I have heard before from others, that I am extremely gratified. I only hope you will not feel sorry over your choice; and right here I want to say that I am glad the members are so particular about picking out their officers from the north, the south, the east and the west. I want to see a feeling of fraternity evidenced from all sections of the country, and I believe that feeling is illustrated in this Association better than elsewhere. If our prosperity as a country is successful, it depends altogether upon a true, fraternal feeling. And now, gentlemen, I want to give you a sentiment: I hope that the wounds that were caused by our late "unpleasantness" may become so callous that the dagger of prejudice may never draw blood again. [Applause.]

THE PRESIDENT—Gentlemen will please prepare their ballots for Secretary.

J. N. LAUDER—Believing, as I do, that the sentiment of this Association on this question is unanimous, I move that the President be authorized to cast the ballot of the Association for J. H. Setchel, as Secretary. [Applause.]

R. H. BRIGGS—I second that motion.

[The motion prevailed by a rising vote.]

THE PRESIDENT—I have much pleasure in casting this vote for Mr. Setchel, whom I now declare to be elected Secretary of this Association for the ensuing year.

R. H. BRIGGS—Mr. Setchel has been one of the most faithful officers this Association has ever had, and I move that we give him three cheers.

[The Association gave three cheers for Mr. Setchel.]

J. H. SETCHEL—Mr. President and Gentlemen: Under the circumstances this is extremely gratifying to me. It shows that if I have not at all times been free from error, still you believe as a body that I have always tried to perform my duty faithfully, and I can only promise you that I will use every endeavor to correct errors, and in every way to promote the interests, good feeling, and usefulness of this Association. [Applause.]

THE PRESIDENT—Gentlemen will now prepare their ballots for Treasurer.

J. S. MCCRUM—I move that the President be instructed to cast the ballot of this Convention in favor of George Richards as Treasurer.

[The motion prevailed by a rising vote.]

THE PRESIDENT—I have much pleasure in casting this vote in favor of our old and worthy treasurer, Mr. Richards.

GEORGE RICHARDS—Gentlemen of the Convention: I thank you for this honor. I shall always perform the duties faithfully, if not too near Canada. (Laughter and applause.)

H. N. SPRAGUE—I move that the Secretary's salary be continued the same as last year.

G. W. STEVANS—I second the motion.

[Carried.]

J. N. LAUDER—The committee to report on the application of Mr. Thomas Shaw for associate membership are of opinion that that gentleman is worthy of election as an associate member.

SECRETARY SETCHEL—As the present application has been confused with Mr. Thomas Shaw, the inventor of a new design of locomotive, I would inquire if it is the same?

J. N. LAUDER—No, sir. This gentleman is an eminent mechanical engineer, of Philadelphia, a member of the Stevans Institute, and in every way qualified.

THOMAS SHAW—Gentlemen: This is the first time that I have had the pleasure of attending any one of your Conventions. I am satisfied that no mechanic could sit in this body one day without considering it a high honor to be one of its members. (Applause.)

J. N. LAUDER—I move that we now proceed to ballot for one member of our Committee of Subjects, to hold office for three years, and I nominate for that place Mr. George Hackney.

[On motion of R. H. Briggs, the President cast the ballot of the Association for George Hackney, as a member of the Subject Committee for the ensuing three years.]

GEORGE HACKNEY—Mr. President and Gentlemen of the Convention: I thank you for the honor conferred upon me. I have no speech to make, but I will try to do my duty. [Applause.]

J. N. LAUDER—I have been asked to introduce the question whether the time has not now arrived to have our Constitution and By-laws subjected to scrutiny, with a view of revising them and bringing them perhaps more into harmony with the present condition of this Association. I should like to have a committee of five appointed and I would move that a committee of five be appointed, of which our present President, J. D. Barnett, be chairman, to take this matter into consideration and report at our next meeting; the balance of the committee to be appointed by Mr. Barnett.

R. H. BRIGGS—I second that motion.

G. W. STEVANS—I would amend by having the committee prepare printed copies of the changes proposed to be made and furnish them to each member thirty days before the next meeting.

J. N. LAUDER—I accept that amendment.

[The motion as amended prevailed.]

THE PRESIDENT—I am not prepared at present to nominate the other members of that committee, but I will do so before we adjourn.

JACOB JOHANN—Probably some of the members are not aware that our old and valued member, Samuel Cummings, resides here in Boston. He is unable to come out of the house, and I am sure it would be a gratification to him if some of the members who have his acquaintance would call and see him before they leave town.

THE PRESIDENT—I hope the members will bear Mr. Cummings in mind. The report of the Committee on Resolutions is next in order.

[The report was read by the Secretary, and, on motion of Mr. Briggs, the same was adopted.

Resolved, That the thanks of the American Railway Master Mechanics' Association are due and are hereby tendered to

The Railroad Companies, and other Transportation Companies, that have extended the courtesy of free transportation to and from the Convention.

To the Rev. George L. Perin, who consented to invoke the Divine blessing upon our proceedings.

To his Honor, Mayor O'Brien, for his kindly words and cordial welcome to this city.

To the New England Railroad Club for the courtesy of a boat excursion through Boston Harbor, and other hospitalities; and to the Committee of this Club our thanks are especially due for the admirable arrangements perfected for the entertainment of the members and their friends.

To Colonel J. W. Johnson and Mr. Walmsley, of the Quincy House, for the personal efforts they made for the comfort and convenience of members and their friends.

To Mr. Joe V. Meigs, for his invitation for the members to examine his Elevated Railroad machinery.

And to the press of Boston, for their impartial reports and notices of our proceedings.

ANGUS SINCLAIR,
ALLEN COOKE,
Committee.

J. N. LAUDER—The members who were at Washington last year will, perhaps, recollect that I introduced Mr. Watkins, the curator of the section of steam transportion of the National Museum, and who made an address to us, setting forth the importance of our contributing anything we could to the Museum. The object, of course, is a worthy one. At the same time, as our Government has established it, they ought to appropriate sufficient money to carry the work on in a satisfactory manner without urging. However, the Convention may think best to take some action looking towards bringing some pressure to bear upon the Government. Here is a communication that I have received from Mr. Watkins.

UNITED STATES NATIONAL MUSEUM.

UNDER DIRECTION OF

THE SMITHSONIAN INSTITUTE,

WASHINGTON, JUNE 15, 1886.

DEAR SIR:—Attached is a copy of a circular letter issued by me to Railway Officers and others the day I sailed for Europe During my absence the petition to Congress has been signed by over 900 gentlemen prominent in railway circles, a few of whose names are given in the accompanying list.

Will you not be kind enough to add your signature, and call the attention of your associates and friends to the subject, requesting their signatures also?

My observations, while abroad, show that the United States is far behind other Nations in its zeal to preserve the history of the Railway and Steamboat, the greatest civilizers of the century.

Do you not agree with me that Congress should be asked to give this matter immediate attention?

Yours respectfully,

J. E. WATKINS,

Curator.

MR. LAUDER—The Supervisory Committee discussed this matter and desired me to telegraph Mr. Watkins and get a copy of the paper he speaks of as containing signatures of railroad officials, which we have received. Now, in response to that circular, there have been some nine hundred signatures forwarded to Honorable Samuel J. Randall, Chairman of the Appropriation Committee of Congress, urging this appropriation. The question before us now is: Shall we comply with Mr. Wat-

kins' request and telegraph to Mr. Randall, as an Association, urging this appropriation? I am not prepared to say whether we should do this thing or not. I think Congress, having the data before them, is capable of saying whether this exhibit should be perpetuated or not. On the other hand, under our system of Government, our representatives sometimes need a little pushing by the expression of public opinion.

G. W. STEVANS—What conclusion did the Supervisory Committee come to about this?

J. N. LAUDER—I would say that they came to no conclusion.

G. W. STEVANS—Then I move that this matter be laid on the table.

[Carried.]

THE PRESIDENT—On the Committee of Amendment of the By-laws, I would appoint, from among the associate members, M. N. Forney, and from our active members, Amos Pillsbury, J. N. Lauder, and J. H. Setchel.

A motion to adjourn is now in order.

[On motion of R. H. Briggs, the Association then adjourned to meet at the call of the Executive Committee.]

COMMITTEES AND SUBJECTS FOR DISCUSSION AT THE TWENTIETH ANNUAL MEETING, JUNE, 1887.

No. 1. *Proportion of Locomotive Cylinders—To give the best Results, what Rule should be followed for Proportioning the Cylinders of an Engine, when the size of driving wheels, weight available for adhesion, and Boiler Steam Pressure are given Quantities:*

CHARLES BLACKWELL, U. P. R. R.
F. L. WANKLYN, Grand Trunk R. R.
T. E. BARNETT, Canada Pacific.

No. 2—*Traction Increasers—Their various Types and Relative Merits, also Cases in which their Use can be Recommended:*

R. R. BRIGGS, Ches. & Ohio S. West.
D. O. SHAVER, Pennsylvania R. R.
T. J. HATSWELL, F. and P. M. R. R.

No 3. *Crossheads and Guide Bars—The various Types in use, the Materials and their Construction, and Results Obtained:*

N. W. HOWISON,
J. B. HENNY, New York & New England.

No. 4. *Steam Packing—The various Forms of Piston Packing in Use and Obtained Results—Also, the most Economical and Satisfactory Packing for Piston Rods, Valve Stems, Regulator, and Air Pump Stuffing Boxes, with Results Obtained:*

J. W. STOKES, Ohio & Mississippi R. R.
ALLEN COOK, Chicago & East. Ill. R. R.
HENRY SCHLACKS, Ill. Central R. R.

No. 5. *Locomotive Preparation—Washing and Lighting up Loco motives—Showing the Best System in Use for Washing out, and most Economical and Expeditious Mode of Raising Steam, and the Necessary Plant for same.*

G. W. ETTENGER, Ches. & Ohio R. R.
W. H. THOMAS, East. Tenn., V. & G. R. R.
T. W. GENTRY, Richmond & Danville R.R

No. 6. *Coaling up Locomotives—The Various Plans in Use, and their Relative Cost and Efficiency.*

J. DAVIS BARNETT, Midland R. R.
JAMES STRODE, Northern Central.
CHARLES GRAHAM, D. L. & W.

No. 7. *Standard Form of Tire Section.*

J. N. LAUDER, Old Colony R. R.
JACOB JOHANN, Chicago and Atlantic.
H. N. SPRAGUE, Pittsburg.

No. 8. *What Control has the Engineer over the Wear of Driving Wheel Tire.*

JOHN MCKENZIE, N. Y. C. & St. L. R. R.
J. S. GRAHAM, L. S. & M. S. R. R.
FRED. B. GRIFFITH, D. L. & W. R. R.

Associate Member Papers.

F. B. MILES.
ROBERT GRIMSHAW.

Obituary Committee—M. M. Pendleton.

C. W. WALKER, S. and R. R. R.
J. F. DEVINE, Wilmington and Delaware.
JAMES MCGLENN, Carolina Central.

Obituary Committee—G. E. Boyden.

J. N. LAUDER, Old Colony R. R.
GEO. RICHARDS, Boston and Providence.
JOSEPH M. WHITLOCK, N. H. & D. R. R.

Obituary Committee—S. H. Dotterer.

R. C. BLACKALL, Del. & Hudson Canal Co.
H. W. EDDY, Boston & Albany R. R.
O. STEWART, Fitchburg R. R.

Obituary Committee—J. C. McCune.

J. S. TURNER, Mex. Central R. R.
H. P. OLCOTT, A. T. & S. F. R. R.
A. H. WATTS, Texas Pacific R. R.

Obituary Committee—John Ivanson.

JAMES PATTERSON, C., I., St. L. & C. R. R.
E. A. CAMPBELL, E. & W. T. R. R.
JAMES MEEHAN, C., N. O. & T. P. R. R.

General Supervisory Committee—Printing and "Boston Fund."

WILLIAM WOODCOCK,
JACOB JOHANN,
R. H. BRIGGS,
GEO. RICHARDS,
J. H. SETCHEL.

Standing Committee on Subjects.

T. B. TWOMBLY, C., R. I. & P. R. R.
CHARLES BLACKWELL, U. P. R. R.
GEORGE HACKNEY, A. T. & S. F. R. R.

Committee of Arrangements, 20th Annual Meeting.

GEO. W. CUSHING, Northern Pacific R. R.
St. Paul.
CLEM. HACKNEY, Union Pacific,
Omaha.
R. W. BUSHNELL, B. C. R. & N. R. R.
Cedar Rapids, Iowa.

CONSTITUTION.

As Amended at the Fourteenth Annual Meeting, Providence, June 14, 1881.

PREAMBLE.

We, the undersigned Railway Master Mechanics, believe that the interests of the Companies by whom we are employed, may be advanced by the organization of an association which shall enable us to exchange information upon the many important questions connected with our business. To this end do we establish the following

CONSTITUTION.

ARTICLE I.

SECTION 1. The name and style of this Association shall be the AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

ARTICLE II.

SEC. 1. The officers of the Association shall be a President, a First and Second Vice-President, a Secretary, and a Treasurer.

SEC. 2. The above-named officers shall be elected separately, by ballot, at each Annual Convention, and a majority of all votes cast shall be necessary to a choice.

SEC. 3. Two Tellers shall be appointed by the President to conduct the election and report the result.

ARTICLE III.

SEC. 1. It shall be the duty of the President to preside in the usual manner at all the meetings of the Association, and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President *pro tempore*.

SEC. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a record of the names and places of residence of all members of the Association, and the name of the road they each represent; to receive and keep an account of all money paid to the Association, and at the close of each meeting deliver the same to the Treasurer, taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association, to receive all bills against the Association, and pay the same, after having the approval of the President; to deliver all paid bills to the Secretary at the close of each meeting, taking a receipted statement of the same; to keep an accurate book account of all transactions pertaining to his office.

ARTICLE IV.

SEC. 1. The following persons may become members of the Association by signing the Constitution, or authorizing the President or Secretary of the Association to sign for them, and pay the initiation fee of one dollar. Any persons having charge of the mechanical department of a Railway, known as "Superintendents," or "Master Mechanics," or "General Foreman," the names of the latter being presented by their superior officers for membership, also two Mechanical Engineers, or the representative of each locomotive establishment in America.

SEC. 2. Civil and Mechanical Engineers, and others whose qualifications and experience might be valuable to the Association, may become Associate Members by being recommended by three Active Members. Their names shall then be referred to a committee, which shall report to the Association on their fitness for such membership. Applicants to be elected by ballot at any regular meeting of the Association, and five dissenting votes shall reject. The number of Associate Members shall not exceed twenty. Associate Members shall be entitled to all the privilege of active members, excepting that of voting.

SEC. 3. Any person who has been or may be duly qualified, and signs, or causes to be signed, the Constitution, as member of the Association, remains as such until his resignation may be voluntarily tendered.

SEC. 4. All members of the Association will be liable for such dues as may be necessary to assess to defray the expenses of the Association, and any member who shall be two years in arrears for annual dues

shall have his name stricken from the roll, and be duly notified of the same by the Secretary.

ARTICLE V.

SEC. 1. The regular meeting of the Association shall be held annually on the third Tuesday in June.

SEC. 2. Regular meetings shall be held at such place as may be determined upon by a majority of the members present at the previous meeting.

SEC. 3. An adjourned meeting may be held at any time and place that a majority of the members present at any meeting may elect.

SEC. 4. The regular hours of sessions shall be from 9 o'clock A. M. to 2 o'clock P. M.

SEC. 5. During the business sessions no communications shall be received or acted upon other than those pertaining to the business of the Association.

SEC. 6. At this, the Thirteenth Annual Meeting, the President shall appoint three members to constitute a standing committee to recommend to the Association at each Annual Meeting subjects for discussion at each succeeding Convention, one member for three years, one for two years, and one for one year, designating the term of each member, and each succeeding year one member of said committee shall be elected by the Association by ballot.

The said committee shall, at one o'clock on the second day of each Annual Convention, report to the Association subjects for discussion at the succeeding Convention.

At 7:30 o'clock of the second day of each Annual Convention there shall be a joint meeting of said committee with an advisory committee, composed of the officers of the Association, which joint committee shall, at ten o'clock on the morning of the third day of each Annual Convention, nominate to the Association the members of the several committees upon said subjects. Said joint committee shall nominate, upon subjects which require reports, from various parts of the country, full committees of three or five, which committees shall be called committees of research, and shall have power to solicit reports from not all but a part of the members of the Association upon such subjects; and upon other subjects said joint committee shall nominate simply the chairman of the committees, who shall have power to select their own associates upon such committees, which shall be called committees of investigation; said joint committee shall also nominate two Associate Members to read papers at the succeeding Annual Meeting.

All committees so appointed, whether of research or investigation, shall meet at four o'clock on the afternoon of the third day of each Annual Convention to plan and divide its work for the ensuing year.

Each committee on research shall, on or before the first day of July of each year, send to the Secretary of the Association a circular letter setting forth the character of reports desired from the members, together with a list of persons to whom said letter shall be sent; and the Secretary shall immediately print and mail the same to such members, with an earnest request that, as a matter of courtesy, full replies thereto shall be sent on or before the first day of April following to the chairman of such committees.

Each committee, whether of research or of investigation, shall, if possible, meet pursuant to the call of its chairman, during the second week in April of each year, for the preparation of its report, which, in the absence of such meeting, shall be prepared by the chairman, and shall immediately forward the same to the Secretary of the Association, by whom it shall be printed and supplied to the members at the commencement of each Annual Convention.

Each report of such Committees shall name the members of the Association from whom replies to said circular letters were requested but not received, on or before the first of April as aforesaid.

ARTICLE VI.

SEC. 1. This Constitution may be amended at any regular meeting of the Association by two-thirds vote of the members present.

Resolution Passed at the Sixth Annual Meeting, Baltimore, Maryland, May, 1873.

Resolved, That no expense shall be incurred by committees except by the unanimous consent of the General Supervisory Committee, given in writing to the Chairman of said Committee, stating the amount to be expended.

Resolution on Boston Fund, Passed at the Eighth Annual Meeting, New York, May, 1875.

Resolved, That the Boston Fund, amounting now, with accrued interest, to $3,620, be invested in Government securities to be selected by the duly appointed Trustees, and not to be disturbed for the purpose of expenditure unless authorized by the majority of members present.

in open Convention, and then only after due notice of a motion to expend the same has been given at the session immediately preceding; and that the interest accumulating shall every year be invested in the same manner as the principal, and a full account of the same be duly reported with other financial statements.

Resolution Adopted at the Ninth Annual Meeting.

Resolved, That members of the Association who have been in good standing for a period of not less than five years, and who through age or other cause cease to be actively engaged in the mechanical departments of railroad service, may, upon the unanimous vote of the Association, be elected " Honorary Members," who shall have their dues remitted and be entitled to all the privileges of regular members except that of voting.

ORDER OF BUSINESS.

1. Reading the Minutes of the previous meeting.
2. Calling the Roll of Members.
3. Signing the Constitution.
4. Report of Secretary.
5. Report of Treasurer.
6. Report of Committees appointed at a previous meeting.
7. Election of Officers.
8. Appointment of a Committee to suggest Subjects for Consideration.
9. Appointment of Miscellaneous Committees; Finance, Printing, and Place of Holding Next Annual Meeting.
10. Report of Committee to suggest Subjects for Consideration.
11. Appointment of Committees to report upon Subjects suggested for Consideration.
12. Unfinished Business.

R. WELLS,
JAMES SEDGLEY,
J. DAVIS BARNETT,
GEO. RICHARDS,
J. H. SETCHEL,
Committee.

NAMES AND ADDRESSES OF MEMBERS.

NAME.	ROAD.	ADDRESS.
Anderson, H.,	No. 204 Dearborn St.,	Chicago, Ill.
Anderson, J. H.,	N. Y. B. & P.,	Providence, R. I.
Anderson, E. D.,	L. N. O. & T. Ry.,	Vicksburg, Miss.
Austin, William L.,	Baldwin Loco. Works,	Philadelphia, Pa.
Ames, L. M.,	B. C. C. & S. W.,	Jersey Shore, Penn.
Ball, Charles A.,	Brooklyn Elevated,	Brooklyn, N. Y.
Barnett, T. E.,	Canadian Pacific,	Vancouver, B. C.
Barton, J. C.,	H. & C. W.,	Hartford, Conn.
Bryan, H. S.,	C. B. & N.,	St. Paul, Minn.
Boon, J. M.,	N. Y. W. S. & B.,	Frankfort, N. Y.
Bushnell, R. W.,	B. C. R. & N.,	Cedar Rapids, Ia.
Brastow, L. C.,	Cent. R. R. of N. J.,	Wilkesbarre, Pa.
Barnett, J. Davis,	Midland R. R.,	Port Hope, Ont.
Black, John,	C. H. & D.,	Lima, O.
Blackall, R. C.,	D. & H. Canal Co.,	Mechanicsville, N. Y.
Bissett, John,	W. & W.,	Wilmington, N. C.
Briggs, R. H.,		Paducah, Ky.
Bradley, S. D.,	G. R. & I.,	Grand Rapids, Mich.
Brigham, L. L.,	Passumpsic	Lyndonville, Vt.
Brownell, F. G.,	B. & L.,	Burlington, Vt.
Berry, L. D.,	D. M. O. & S.,	Osceola, Ia.
Brokaw, W. I.,	St. L. & H.,	Hannibal, Mo.
Bothwell, James,	C. & N. W.,	Baraboo, Wis.
Brooks, L. R.,	Lima Iron Works,	Birmingham, Ala,
Blackwell, Charles,	U. P.,	Omaha, Neb.
Bosworth, B. C.,	C. V.,	Canton, O.
Bean, John,	C. V.,	Canton, O.
Beckert, A.,	B. & O.,	Mt. Clare, Md.
Chapman, T. L.,	M. & N. N.,	Richmond, Va.
Cullen, James,	N. & C.,	Nashville, Tenn.
Campbell, E. A.,	E. & W. T.,	Houston, Tex.
Campbell, John,	L. V.,	Delano, Pa.

NAME.	ROAD.	ADDRESS.
Carscadden, R. O.,	C. R. I. & P.,	Trenton, Mo.
Chapman, N. E.,	333 Walnut St.,	Philadelphia, Pa.
Chapman, J. W.,	C. & O.,	Richmond, Va.
Coolidge, G. A.,		Boston, Mass.
Clark, David,	L. V.,	Hazelton, Pa.
Clark, Peter,	N. & N. W.,	Toronto, Can.
Cooper, H. L.,	L. E. & W.,	Lafayette, Ind.
Cushing, Geo. W.,	N. P.,	St. Paul, Minn.
Crockett, John F.,	B. L. & N.,	Boston, Mass.
Clifford, J. G.,	L. & N.,	Bowling Green, Ky.
Cook, Allen,	C. & E. I.,	Chicago, Ill.
Cook, John S.,	Georgia,	Augusta, Ga,
Carson, M. T.,	M. & O.,	Whistler, Ala.
Collier, M. Lamar,	W. & A.,	Atlanta, Ga.
Cromwell, A. J.,	B. & O.,	Baltimore, Md.
Clark, Isaac W.,	C. F. & Y. V.,	Fayetteville, N. C.
Davis, James A.,	N. T. & Q.,	Deseronto, Ont.
Davis, N. L.,	Rutland,	Rutland, Vt.
Devine, J. F.,	W. & W.,	Wilmington, N. C.
Dripps, W. A.,	No. 3224 Walnut St.,	Philadelphia, Pa.
Domville, C. K.,	Gt. W. of C.,	Hamilton, Ont.
Downe, Geo.,	Govt.,	Sydney, Aus.
Dotterer, D. H.,	A. T. & S. F.,	Raton, N. M.
Ettenger, G. W.,	C. & O.,	Richmond, Va.
Evans, Edward.	C. W. & B.,	Chillicothe, O.
Ellis, Matt.,	C. St. P. M. & O.,	St. Paul, Minn.
Eddy, H. W.,	B. & A.,	Springfield, Mass.
Eblin, James,	L. R. & Ft. S.,	Argenta, Ark.
Elliott, Henry,		E. St. Louis, Ill.
Eckford, James,		Bellevue, O.
Eastman, A. G.,		Sutton, Ont,
Ennis, W. C.,	N. Y. S. & W.,	Wortendyke, N. J.
Foss, J. M.,	Cent. Vt.,	St. Albans, Vt.
Fuller, William,		Cleveland, O.
Finlay, L.,	H. S.,	Malvern, Ark.
Foster, W. A.,	Fitchburg,	Fitchburg, Mass.
Fowle, I. W.,	V. & M.,	Vicksburg, Miss.

NAME.	ROAD.	ADDRESS.
Ferguson, G. A.,	B. & L.,	Lake Village, N. H.
Fenwick, A.,	G. B. W. & St. P.,	Ft. Howard, Wis.
Flahaven, W. M.,	P. & W.,	Alleghany, Pa.
Gentry, T. W.,	R. & D.,	Atlanta, Ga.
Griffith, Fred B.,	D. L. & W.,	E. Buffalo, N. Y.
Greenwood, A. W.,	East Broad Top,	Orbisona, Pa.
Gates, G. W.,	W. Ry. of N. C.,	Salisbury, N. C.
Garrett, H. D.,	Penn.,	Philadelphia, Pa.
Griggs, Albert,	P. & W.,	Providence, R. I.
Gordon, H. D.,	P. W. & B.,	Wilmington, Del.
Graham, Charles,	D. L. & W.,	Scranton, Pa.
Gilson, Gregg D.,		
Gordon, James T.,	Concord Ry.,	Concord, N. H.
Graham, J. S.,	L. S. & M. S.,	Buffalo, N. Y.
Gilmore, W. L.,	L. S. & M. S.,	Cleveland, O.
George, Nathan M.,	D. & N.,	Danbury, Conn.
Galloway, A.,	Box 401,	Cambridge, O.
Haynes, O. A.	M. P.,	St. Louis, Mo.
Hinman, M. L.,	Brooks' Loco. Works,	Dunkirk, N. Y.
Headden, John,	Rogers' Loco. Works,	Patterson, N. J.
Harding, B. R.,	R. & G.,	Raleigh, N. C.
Hollister, J. D.,		Palatka, Fla.
Ham, C. T.,	Buffalo Steam Gauge Co.,	Rochester, N. Y.
Hewitt, John,	1323 Jef Ave.,	St. Louis, Mo.
Hodgeman, S. A.	Lobdel Car Wheel Works,	Wilmington, Del.
Haggett, J. C.,	D. & A. V.,	Dunkirk, N. Y,
Hackney, Geo.,	A. T. & S. F.,	Topeka, Kan.
Hackney, Clem.,	Union Pacific,	Omaha, Neb.
Howison, N. W.,		Watertown, N. Y.
Henny, John, Jr.,	N. Y. N. H. & H.,	New Haven, Conn.
Henny, J. B.,	N. Y. & N. E.,	Boston, Mass.
Howe, Geo. E.,	St. J. & L. E.,	St. Johnsbury, Vt.
Hatswell, T. J.,	F. & P. M.,	East Saginaw, Mich.
Hovey, J. P.,	Union Pacific,	Larime, W. T.
Horniblow, J. P.,	Government Ry.,	Queensland, Australia.
Hall, J. W.,	L. & N.,	Montgomery, Ala.
Hickey, John,	M. L. S. & W.,	Kaukauna, Wis.
Hoffecker, W. L.,	A. T. & S. F.,	Raton, New Mex.

NAME.	ROAD.	ADDRESS.
Holman, W. L., . . .	Penn. Ry., ...	Renova, Pa.
Harrison, W. H., . .	B. & O.	Baltimore, Md.
Hanson, C. F., . . .	Gt. Western Ry., ...	London, Ont.
Hobert, C. C., . . .	Oregon Ry. & Navigation Co.	The Dallas, Oregon.
Hames, S. W., . . .	P. &. L. E. Ry., ...	Pittsburg, Pa.
Haggerty, G. A., . .	New Brunswick, ...	St. Johns, N. B.
Hamis, Geo. D., . .	R. & A.,.	Richmond, Va,
Hendee, ...	J. T. & K. W., ...	Palatka, Fla.
Hall, Sen. Don Diego, ...		Santiago, Chili, S. A.
Inness, Thos. B.,. . .	No. 115 Broadway, ...	New York.
Johnson, J. B.,. . . .	A. M., ...	Helena, Ark.
Johann, Jacob,. . . .	T. P. Ry., ...	Marshall, Tex.
Jeffrey, E. T., ...	Illinois Central, ...	Chicago, Ill.
Jacques, Richard,	Care Hemmingway & Brown,	75 State St., Boston, Mass
Kielmer, John T., . .	No. 812 East York Street,	Philadelphia, Pa.
Kinsey, J. I., ...	L. V. Ry., ...	Easton, Pa.
Keeler, Sanford,. . .	F. & P. M., ...	East Saginaw, Mich.
Kolseth, Henry S.,. .	B. & L., ...	East Cambridge, Mass.
Lythgoe, Joseph,. . .	R. I. Loco. Works,. . . .	Providence, R. I.
Leeds, Pulaski, . . .	L. & N.,.	Louisville, Ky.
Losy, Jacob, ...	Steam Forge Co., ...	Louisville, Ky.
Lauder, J. N., ...	Old Colony Ry., ...	Boston, Mass.
Leech, H. L., ...	No. 1 Rollins St.,.	Boston, Mass.
Lannon, Wm., Chief Eng.	House of Representatives,	Washington, D. C.
Lewis, W. H., ...	D. L. & W., ...	Kingsland, N. J.
Lape, John R.,. . . .	W. St. L. & P., ...	Moberly, Mo.
Lowe, Geo. W., . . .	C. & N. W., ...	Clinton, Ia.
Millholland, J. A., . .	G. C. & C., ...	Cumberland, Md.
Maynes, W. C., . . .	C. & E. I.,.	Chicago, Ill.
Meehan, James, . . .	C. N. O. & T. P.,.	Ludlow, Ky.
McGrayel, John M., .	D. M. & F. D.,.	Des Moines, Ia.
Middleton, Harry, . .	L. & N.,.	Louisville, Ky.
Mulligan, J., ...	Conn. River, ...	Springfield, Mass.
Mitchell, A., ...	L. V., ...	Wilkesbarre, Pa.
Morse, G. F., ...	Portland Loco. Works, . .	Portland, Me.

NAME.	ROAD.	ADDRESS.
McGlenn, James,	Carolina Central,	Laurinburg, N. C.
McKenna, J.,	I. D. & S.,	Indianapolis, Ind.
McCrum, J. S.,	M. R. Ft. S. & G.,	Kansas City, Mo.
McVay, John,		Chattanooga, Tenn.
Morrell, J. E.,	C. R. I. & P.,	Davenport, Ia.
Minshall, E.,	N. Y. O. & W.,	Middletown, N. Y.
McFarland, Wm.,	St. P. & D.,	St. Paul, Minn.
Montgomery, Wm.,	N. J. S.	Manchester, N. J.
Millen, Thomas,	N. Y. C. & N.,	New York City.
Mills, C. W.,	R. & P.,	Rochester, N. Y.
Manley, Bassil,	A. & N. C.,	Newbern, N. C.
McKenzie, John,	N. Y. C. & St. L.,	Cleveland, O.
Noble, L. C.,	H. & T. C.,	Houston, Tex.
Olcott, H. P.,	A. T. & S. F.,	Coolige, Kan.
Ortton, John,	N. Y. C.,	W. Albany, N. Y.
Paxson, L. B.,	P. & R.,	Philadelphia, Pa.
Petrie, Ira,	J. & S. E.	Jacksonville, Fla.
Pringle, R. M.,	No. 1101 N. Second St.,	St. Louis, Mo.
Perry, F. A.,	Cheshire Ry.,	Keen, N. H.
Prescott, G. W.,	No. 25 S. 4th Street,	St. Louis, Mo.
Purves, T. B.,	B. & A.,	E. Albany, N. Y.
Place, T. W.,	Illinois Central,	Waterloo, Ia.
Porter, J. S.,	I. B. & W.,	Sandusky, O.
Patterson, J. S.,	C. I. St. L. & C.,	St. Louis, Mo.
Player, John,	Central Ry. of Iowa,	Marshalltown, Ia.
Pillsburry, Amos,	Eastern Ry.,	Boston, Mass.
Pitkin, A. J.,	Schenectady Loco. Wks.,	Schenectady, N. Y.
Prescott, G. H.,	T. H. I. & St. L.,	Terre Haute, Ind.
Richards, Jackson,	No. 908 Green St.,	Philadelphia, Pa.
Richardson, E.,	Shenandoah Valley.	Greenville, Pa.
Richards, Geo.,	B. & P..	Boston, Mass.
Robb, W. D.,	L. & N.,	Pensacola, Fla.
Ross, Geo. B.,	No. 293 S. Div. St.,	Buffalo, N. Y.
Roberts, E. M.,	A. C. & I. Ry.,	Ashland, Ky.
Renshaw, W.,	I. C.,	Chicago, Ill.
Rennel, Thos.,	M. & L. R.,	Argenta, Ark.
Richardson, R. M.,	M. P.,	Little Rock, Ark.

NAME.	ROAD.	ADDRESS.
Robertson, W. J.,	C. Vt. Ry.,	St. Albans, Vt.
Shaffer, Aug.,	Maysville Water Works,	Maysville, Ky.
Stone, W. A.,	N. Y. & N. E.,	Norwich, Conn.
Smith, W. F.,		Carlin, Nev.
Sanborn, C. A.,	E. St. Louis,	Carondelet, Mo.
Stokes, J. W.,	O. & M.,	Pana, Ill.
Sullivan, A. W.,	I. C.,	Chicago, Ill.
Smith, Howard M.,	R. & D.,	Alexandria, Va.
Sanborn, J. M.,	L. S. & M. S.,	Norwalk, O.
Scruten, C. E.,	E. & W. of A.,	Cedartown, Ga.
Sellers, Morris,	No. 6 Ashland Block,	Chicago, Ill.
Schlacks, Henry,	I. C.,	Chicago, Ill.
Smith, W. T.,	M. & N. N.,	Huntington, W. Va.
Smith, Allison D.,	Gov't Ry's,	New Zealand.
Strode, James,	N. C.,	Elmira, N. Y.
Stearns, W. H.,	Conn. River,	Springfield, Mass.
Shaver, D. O.,	Pennsylvania,	Pittsburgh, Pa.
Setchel, J. H.,	Brooks' Loco. Works,	Dunkirk, N. Y.
Smith, Will,	Boston & Maine,	Boston, Mass.
Sedgwick, Ed. B.,	M. C.,	Silas, Mex.
Stevens, Geo. W.,	L. S. & M. S.,	Cleveland, O.
Sprague, H. N.,	H. K. Porter & Co.,	Pittsburgh, Pa.
Selby, W. H.,		Moberly, Mo.
Simonds, G. B.,		Sedalia, Mo.
Sitton, B. J.,	E. T. Va. & Ga.,	Knoxville, Tenn.
Swanston, Will,	J. M. & I.,	Indianapolis, Ind.
Steel, W. J.,		Nashville, Tenn.
Short, Wm. A.,	O. & L. C.,	Malone, N. Y.
Stewart, O.,	Fitchburg Ry.,	Fitchburg, Mass.
Stinard, F. A.,	N. Y. & G. L.,	Pompton Junc., N. Y.
Stapf, F. M.,	C. V. & C.,	Carmel, Ill.
Smart, C. E.,	Michigan Central,	Jackson, Miss.
Shaw, Thos.,	No. 915 Ridge Ave.,	Philadelphia, Pa.
Tandy, Harry,	Brooks Loco. Works,	Dunkirk, N. Y.
Twombly, Fred M.,	O. C.,	Boston, Mass.
Twombley, T. B.,	C. R. I. & P.,	Chicago, Ill.
Turreff, W. F.,	C. C. C. & I.,	Cleveland, O.
Taylor, J. K.,	B. & L.,	Boston, Mass.

NAME.	ROAD.	ADDRESS.
Turner, J. S.,	M. C.,	Jimlico, Mex.
Tumser, John,		Seymour, Ind.
Twombly, A. W.,	O. C.,	Taunton, Mass.
Thow, Wm.,	S. A. Ry.,	Adelaide, Australia.
Tregelles, Henry,	N. Y. L. E. & W.,	Salamanca, N. Y.
Teal, S. A.,	S. C. & P.,	Missouri Valley, Ia.
Thomas, W. H.,	E. T., Va. & Ga.,	Knoxville, Tenn.
Thompson, John,		Boston, Mass.
Thompson, W. A.,	M. H. & O.,	Marquette, Mich.
Thomas, C. F.,	M. & N. N.,	Richmond, Va.
Torrence, John,	E. & T. H.,	Evansville, Ind.
Underhill, A. B.,	B. & A.,	Springfield, Mass.
Ulmo, H. A.,	C. & S.,	Savannah, Ga.
Van Vechten, J.,	N. Y. L. E. & W.	Susquehanna, Pa.
Wakefield, S. W.,	C. R. I. & Pac.,	Keokuk, Ia.
Watrous, Geo. C.,	D. L. & N.,	Iona, Mich.
Wheeler, M. C.,	W. I. & N.,	Marshalltown, Ia.
West, Geo. W.,	N. Y. P. & O.,	Cleveland, O.
Walsh, Thomas,	L. & N.,	Mt. Vernon, Ill.
Warren, W. B.,	I. B. & W.,	Indianapolis, Ind.
Warren, Beriah,	I. B. & W.,	Indianapolis, Ind.
Wells, Reuben,	L. & N.,	Louisville, Ky.
Wiggins, J. E.,		Marshall, Tex.
Weisgerber, E. L.,	B. & O.,	Newark, O.
Walker, C. W.,	S. & R.,	Portsmouth, Va.
Wanklyn, F. L.,	Grand Trunk,	Montreal, Can.
Wilard, Daniel,	M. S. S. M.,	Turtle Lake, Wis.
Weaver, D. L.,	No. 1710 15th St.,	Louisville, Ky.
Wilder, F. M.,		Binghamton, N. Y.
Wightman, D. A.,	Pittsburgh Loco. Works,	Pittsburgh, Pa.
White C. M.,	L. & N.,	Birmingham, Ala.
Watts, Amos,	Texas, Pacific,	Marshall, Tex.
Williams, C. G.,	Central of N. J.,	Communipaw, N. J.
Whitney, H. A.,	Intercolonial,	Moncton, N. B.
White, A. M.,	Schenectady Loco. Works,	Schenectady, N. Y.
Williams, Richard,	Rome Loco. Works,	Rome, N. Y.

NAME.	ROAD.	ADDRESS.
Whitlock, Joseph, M.,	N. H. & D.,	New Haven, Conn.
White, J. F.,	Illinois Central,	Water Valley, Miss.

ASSOCIATE MEMBERS.

Coleman, John A.,		Providence, R. I.
Dean, F. W.,		E. Taunton, Mass.
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Grimshaw, Robt.,	No. 5 Dey St.,	New York.
Gordon Alex.,	Niles Tool Works,	Hamilton, O.
Hill, John W.,		Cincinnati, O.
Lyne, Lewis F.,	No. 307 Grove St.,	Jersey City, N. J.
Lilly, J. O. D.,		Indianapolis, Ind.
Miles, F. B.,		Philadelphia, Pa.
Sellers, Coleman,		Philadelphia, Pa.
Sinclair, Angus,	Asso. Editor Nat. Car Builder,	Chicago, Ill.
Shaw, Thomas,	No. 915 Ridge St.,	Philadelphia, Pa.
Smith, Willard A.,	Chicago Ry. Review,	Chicago, Ill.
Wheelock, Jerome,		Worcester, Mass.

HONORARY MEMBERS.

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Dripps, Isaac,	No. 345 Walnut St.,	Philadelphia, Pa.
Wilson, Eddy,		Springfield, Mass.
Peddle, C. R.,		Terre Haute, Ind.
Perrin, P. J.,	Taunton Loco. Works,	Taunton, Mass.
Parry, C. T.,	Baldwin Loco. Works,	Philadelphia, Pa.
Philbrick, J. W.,		Waterville, Me.
Robinson, W. A.,		Hamilton, Ont.
Sedgely, James,		Cleveland, O.
Town, H. A.,	No. 256 First Ave.,	Minneapolis, Minn.
White, J. L.,		Danville, Ill.
Williams, E. H.,	Baldwin Loco. Works,	Philadelphia, Pa.

OBITUARY.

Milo M. Pendleton.

On the 6th of November, 1885, Milo M. Pendleton died, aged 53 years and 7 months.

He was born in Springfield, Mass., on the 31st day of March, 1832, and came to the S. & R. R. R. in Portsmouth, Virginia, about 1851, as a locomotive engineer, serving in that capacity for a number of years, and was then appointed foreman, which position he held until the death of his brother, J. B. Pendleton, when he received the appointment as Superintendent of Machinery, which was held until his death.

For several years prior to his death, his intimate friends beheld with regret the gradual undermining of his constitution, but with an iron will, which was characteristic of the man, he always presented a cheerful front, and would never speak of his sufferings. He was a man of genial disposition, kind and indulgent, and always ready to extend a helping hand.

To his family his death was a severe blow, as they lost husband, father, companion, and friend. The beautiful monument erected by loving hands over his grave, attests their affection and remembrance. Those under his charge mourned his loss more for his advice and counsel, and nothing but expressions of regret were heard from their lips. Respect and obedience to his orders were given with an alacrity gained by kindness rather than discipline. He was followed to his last resting place in Portlocks cemetery by a vast concourse of citizens, although a severe rain storm prevailed at the time. May his good deeds be cherished and held in sweet remembrance by those who lost so much by his fall.

C. W. WALKER,
JOHN F. DIVINE,
JAS. McGLENN.

George E. Boyden.

George E. Boyden, a member of this Association, died at his home in Readville, Hyde Park, Mass., September 8, 1885, of typhoid fever, after an illness of thirty days.

Mr. Boyden was born in Wrentham, Mass., May 22, 1838. When 15 years old he entered the service of the Boston, Hartford, & Erie R. R., and remained in the employ of that road and its successor, the New York & New England R. R. in the various capacities of brakeman, fireman, and engineer, until July, 1871, when he was appointed Master Mechanic. In 1880 the N. Y. & N. E. Co., having absorbed the Hartford, Providence & Fishkill R. R , Mr. Boyden was appointed Superintendent of Motive Power of the consolidated road, which position he resigned in May, 1882, and connected himself with the Crosby Steam Gauge and Valve Co., of Boston, as traveling agent. In February, 1884, he again entered the service of the N. Y. & N. E. R. R. as Master Mechanic of the Eastern Division, and in the spring of 1885, resigned to accept an important position with the Eames Vacuum Brake Co., being actively engaged in his duties with that company when attacked by the disease which ended his life.

Mr. Boyden was a man of marked qualities of mind and heart. Modest and unassuming in his deportment, kind and condescending in his relations with his subordinates, his dealings always governed by the strictest integrity, he won alike the regard and esteem of those who met him in the walks of business life, and the respect and confidence of those who were employed under his direction.

His acquaintance with railroad officials was very extensive. He was a constant attendant at the regular meetings of this Association, and, though his voice was seldom heard in its deliberations, his sound judgment and wide experience rendered him a safe and judicious counselor and a valuable member of the Association.

Mr. Boyden possessed mechanical ability of a high order. Starting in life with little or no opportunity of acquiring a technical education, he so improved the opportunities that arose, as to merit and win the approval of his superiors, and to his native qualities of ap-

plication and good judgment are entirely due his promotions to the responsible and important positions successfully filled by him.

His funeral at Norwood, Mass., was held on Sunday, September 11th. He was buried with Masonic honors by Orient Lodge, F. and A. M., of Norwood, of which he was a member. The funeral was attended by a very large number of his friends and associates, attesting by their presence the regard and esteem in which he wa held.

He leaves a family, consisting of wife, two sons and two daugh ters. To them, thus bereft of their kind protector, this Association tenders the assurance of its most profound and sincere sympathy. As an Association and individually, we mourn his loss, and feel that by his death one more respected name is added to the lengthening list of our associates who have gone before.

J. N. LAUDER,
GEO. RICHARDS,
Committee.

Sept. 22, 1886.

Samuel H. Dotterer.

Mr. Samuel H. Dotterer, late Master Mechanic of the Delaware & Hudson Canal Co., Pennsylvania Division, was born in the city of Reading, Pa., July 29, 1837, and died at Carbondale, Pa., November 12, 1885.

Mr. Dotterer entered the machine shops of the Delaware, Lackawanna & Western Railroad Co., at Scranton, as an apprentice, in the spring of 1851. In the early part of 1855, he was sent out on the road as a locomotive engineer, and continued as such until the spring of 1856, when he gave up the position to accept that of Master Mechanic of the Dubuque and Sioux City Railroad, which he continued to hold until the road passed into the contro of the Illinois Central Railroad Co. He then returned to Scranton, Pa., and entered the service of the D., L. & W. R. R. Co. as locomotive engineer, where he remained until October 1, 1871, when he accepted the position of Master Mechanic of the Delaware & Hudson Canal Co., which position he held up to within a short time of his death. Mr. Dotterer became a member of this Association June, 1883.

He was a faithful man in all his relations, and highly appreciated by his associates. For the last fifteen years of his life he was afflicted with rheumatic gout, which caused him great suffering, at times unable to move.

He leaves a wife and three daughters to mourn his loss, to whom we extend the sympathy of this Association.

R. C. BLACKALL,
O. STEWART,
H. W. EDDY.

James G. McCuen,

A member of this Association, and well and favorably known, late Superintendent M. P. and M., on the Atlantic & Pacific Railroad, died November 19, 1885, of heart disease, at Albuquerque, New Mexico, in the 43d year of his age.

Mr. McCuen served his apprenticeship in the shops of the Vermont Central Railway, at St. Albans, and remained with this company a few years as journeyman. After leaving their service he went West to work on the Central Pacific Railway, and when there only a short time his merits met with due reward by his appointment as Master Mechanic, at Terrace, Utah. After having held this position for some years, he resigned to accept an appointment as Master of Machinery in the mining districts of Nevada, which position he later on resigned, in order to accept the appointment as General Master Mechanic of the Sonora Railway, in Mexico. Leaving the employ of this company in 1883, he accepted the position of Master Mechanic on the Mexican Central Railway, and was located at the principal shops of the company, at Chihuahua, which position he held until September, 1885, when he was honored by the appointment of General Superintendent M. P. and M. of the Atlantic & Pacific Railway. This position he occupied only a few months, when it pleased the Almighty Ruler of the universe, in His infinite wisdom, to remove him from our midst.

Mr. McCuen was an active, energetic and capable man, and commanded the respect of all who came in contact with him. He was possessed with extensive practical knowledge, and his thorough

business qualities admirably adapted him for the management of the great interests which had been entrusted to his care. Among the railroad men throughout the country he was well known, and had many warm friends and admirers.

Mr. McCuen had been a widower for the last eight years, and leaves an only daughter, ten years of age, who is now attending school in San Francisco, California.

His untimely end, in the prime of life, will be deeply deplored by all the members of this Association, and we extend our heartfelt sympathy to the daughter and relatives of our respected brother, and that while we bow in humble submission to the will of Divine Providence, we deeply feel the loss of one who so endeared himself to our members by the noble traits of his character.

J. S. TURNER,
Chairman.
J. S. TURNER,
H. P. OLLCOTT,
A. H. WATTS,
Committee.

John Ivinson

Died of malarial fever, after a long and lingering illness of two years and seven months, in Cincinnati, on the 7th of October, 1885, aged 58 years. He was born in the West Indies, on June 16, 1827. When eight years of age he left there and went to England, where he received his education and learned his trade as machinist. Mr. Ivinson then came to America, where he became connected with a number of roads, in different capacities; most prominent among the roads were the Little Miami, now a division of the P., C. & St. L. Railway; also, the Evansville & Crawfordsville Railway, where he held the position of Master of Machinery and Master of Trains. On leaving which, Mr. Ivinson was made Superintendent of the Kansas City Eastern Railway, where he remained until appointed Master of Machinery of the Cincinnati Southern Railway, in 1880, remaining with same for several years. Mr. Ivinson was generous and kind-hearted, and

very successful as a manager and railroad man. He was beloved by all that came in contact with him, and as a husband and father true and affectionate. His death will be mourned by his many friends, also by the members of the American Railway Master Mechanics' Association, of which organization he was an honored member. The Association tender their respective sympathies to the widow and children, who survive him.

J. S. PATTERSON,
JAMES MEEHAN,
E. A. CAMPBELL,
Committee.

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